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WORLD CROPS

The International Journal of Agriculture

VOLUME 13, No. 11 NOVEMBER 1961

Photo: Wakayama Prefectural Horticultural Station, Japan (By courtesy of G L Holt)

Boron deficiency in citrus results in fruit of misshapen appearance with thickened rind and low juice and sugar content. *See page 416*

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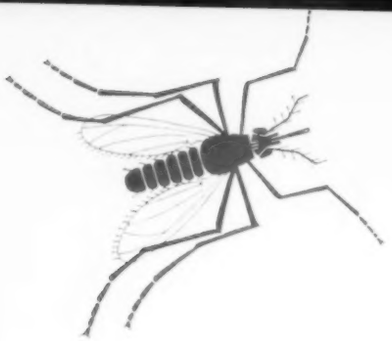

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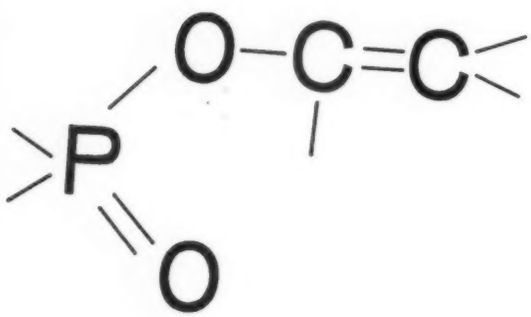

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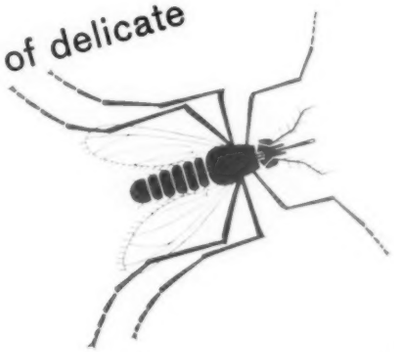

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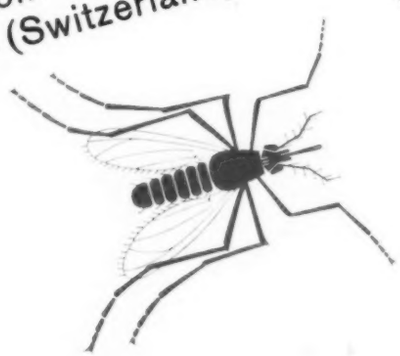

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WORLD CROPS

The International Journal of Agriculture

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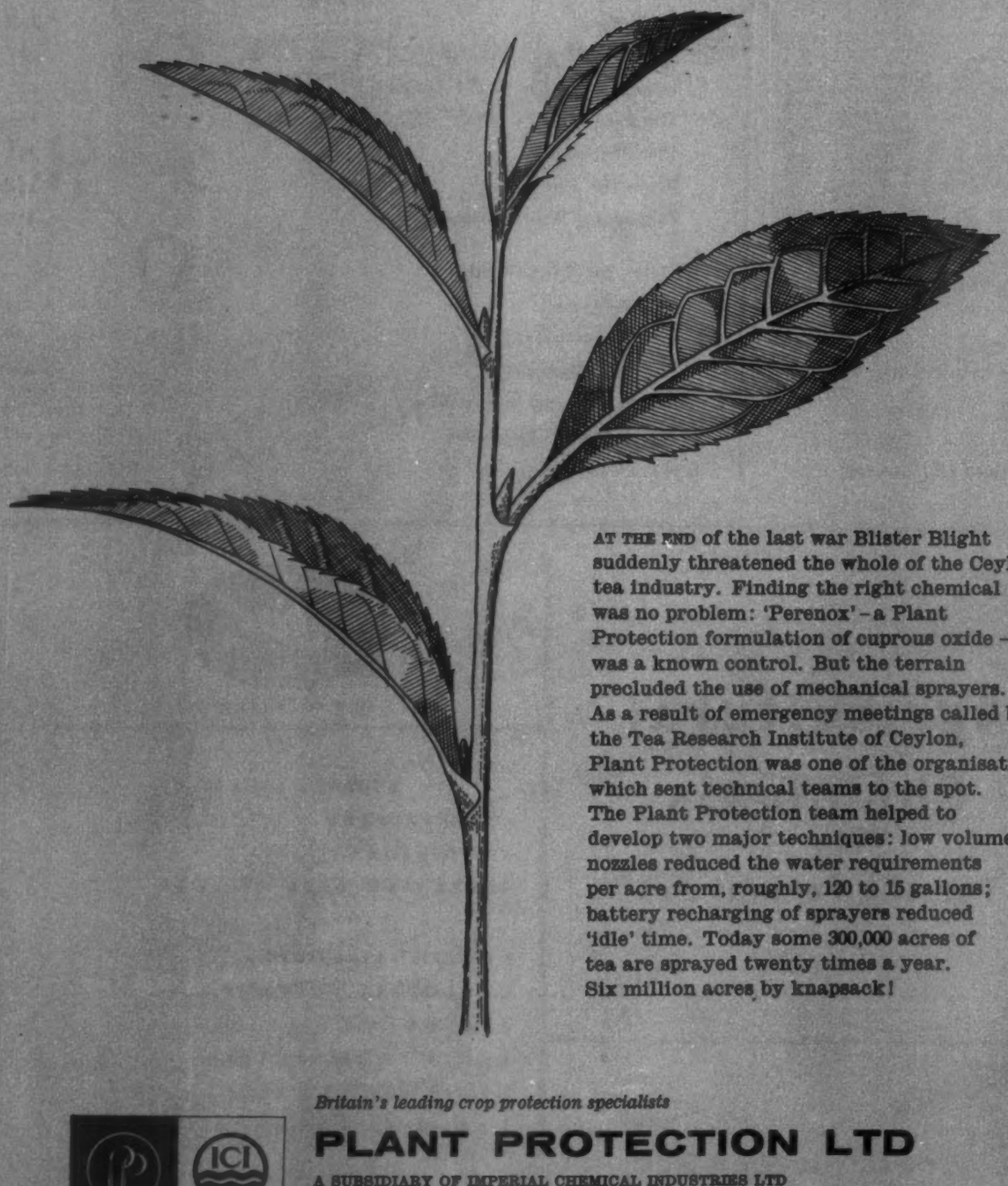
Tea · Ceylon · 1946



AT THE END of the last war Blister Blight suddenly threatened the whole of the Ceylon tea industry. Finding the right chemical was no problem: 'Perenox' – a Plant Protection formulation of cuprous oxide – was a known control. But the terrain precluded the use of mechanical sprayers. As a result of emergency meetings called by the Tea Research Institute of Ceylon, Plant Protection was one of the organisations which sent technical teams to the spot. The Plant Protection team helped to develop two major techniques: low volume nozzles reduced the water requirements per acre from, roughly, 120 to 15 gallons; battery recharging of sprayers reduced 'idle' time. Today some 300,000 acres of tea are sprayed twenty times a year. Six million acres by knapsack!

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Editorial Comment

Crop Drying and Processing

THE MOISTURE IN FARM CROPS can be extracted in a variety of ways, but the commonest and the cheapest, but not always the best, is by sun-drying or air-drying. While these methods are feasible and eminently satisfactory in those countries where the climate is sufficiently reliable for the farmer to be able to count on 5-7 days of continuous sunshine with cloudless skies, these conditions are rarely found in practice.

Crop Drying in the Tropics

The price of a primary product like copra, the dried meat of the coconut, is determined by the fact that in certain places, where such periods of continuous sunshine can be relied upon, a perfectly white product can be obtained inexpensively simply by sun-drying; in fact, Cebu sun-dried and the former Cochin sun-dried copra both obtained top market prices.

This places countries like Malaya, Ceylon and Indonesia, where the climate is unreliable, at an economic disadvantage in that the quality of copra produced by sun-drying is so variable that a 'mixed' grade dominates the rural markets and determines the price paid to the villager, irrespective of the quality of the small 'parcel' he may have to offer. In fact, it may actually pay him not to produce a white dry product, because its weight will be much less than that of half-dried copra.

The wet meat of the coconut will deteriorate as quickly as a piece of wet fish, and equally both can be preserved by prompt, continuous and adequate drying; witness the 'Bombay duck' of India or the *ikan kering** of Malaya. The inner surface of a raw coconut, with its yeasts, offers perfect conditions for the growth of a succession of moulds and invasion by a series of copra-consuming insects which live and multiply on, or in, the mycelia. With the inevitable result that delayed drying or the sale of the product to a village dealer in a half-dried or a three-quarters-dried condition will result in bulking various parcels, all more or less in a state of active decay.

This does not matter to the oil miller, because he pays for the quantity and the quality he receives and he is able either to refine the extracted oil or, if it is too rancid, use it in soap-making.

This economic stalemate has gone on for many years, partly because there is a natural resistance to change in marketing conditions. The farmer, too, is a sturdy individualist who hates being 'messed about' by officials or organised into groups for some form of collective production.

Nevertheless, there are men who are prepared to combine for their mutual profit, providing they can be sure that the profits are wholly theirs and are not siphoned off to maintain an army of officials in a much higher state of comfort and living than their own. For such co-operating groups the 'Chula' battery drier is the answer (see WORLD CROPS, 1960, **12**, 386).

For the sturdy individualist, who can be sure of a buyer for small lots of copra of top quality, there is the small, inexpensive Cooke kiln, which can be made from locally available materials and which, when properly operated, will produce a perfect product (see WORLD CROPS, 1956, **8**, 435 and 489).

Crop Drying in Europe

Coming nearer home, the crops which need to be dried are grass and grain. In both cases the departures from the traditional methods are among the outstanding developments in recent years.

Increasing attention has been paid to conserving grass of the highest nutritive quality as winter feed for livestock. The age-old method of hay-making, which did not produce feed of the best quality for various reasons, is being partially replaced by systems of artificial drying or by the production of silage.

Today the grass crop is being cut more frequently and in the young leafy stage, when it is more succulent and contains more sap, whereas a more mature crop is more stemmy and drier and is not of such high nutritive value. Artificial drying is, however, an expensive business and, particularly in view of the higher moisture content of the crop, it is desirable to remove at least a third of the moisture by swath drying in the field, a process known as 'wilting'.

Mechanical hay-making, otherwise known as 'tedding', should be commenced as soon as possible after cutting and the practice is growing of hitching a tedder, crimper or swath mounder in line behind the mower or crop harvester. The earlier cutting of grass and uncertainties of the weather makes it essential to accelerate field drying, but the age-old tradition of leaving the crop lying in the field undisturbed for 24-48 hours after cutting dies hard.

The purpose of these mechanical operations is not only to retain the palatability and nutritive value of the grass, but also to reduce the moisture content from, say, 80-85% to 60% or even much lower. This then makes grass drying by artificial means an economic proposition.

Grass Drying in Eire

Artificial drying can be effected either by the system of blowing air into barns filled with hay or into stacks of bales or by an up-draught of hot air through a bin

* Dried fish

or silo with the grass resting on a grille. There are on the market various types of tray driers, portable blowers, conveyor driers and rotary driers, and various sources of heat are employed—oil, electricity and pulverised coal. Recently we inspected a most effective process for the production of grass meal based on the use of pulverised peat.

Although dried peat has only half the calorific value of the equivalent weight of coal, necessity becomes the mother of invention when a country like Ireland, which has no oil or coal resources, wants to develop industries and provide employment for her people. The establishment of a large grass-drying factory on a mineral 'island' in the centre of one of the wettest and most desolate peat bogs in Ireland is indeed a wonderful achievement.

Gowla Farm—1,500 acres in extent—has been the scene of a reclamation experiment which was started by the Irish Sugar Co. in 1951 and has been so successful that it has altered the nation's attitude to its 4 million acres of bogs and done more to bring hope to the western counties of Eire than any other single project, according to Norrie Tomter writing in the *Scotsman*.

On what was once an impenetrable waste, equally dangerous to man and beast, there are now a thousand acres of luscious grassland, producing 2½ tons of grass meal to the acre, 50 acres of sugar-beet, 28 acres of potatoes, 50 acres of wheat, 28 acres of barley, 50 acres of carrots and an extensive area under celery for canning.

To achieve this the land has had to be drained, treated with ground limestone, the major fertilisers and the essential trace elements. The ground is still very soft and in places it is still necessary to move fast, and the frequency of deep open drains makes direct grazing by cattle and sheep too dangerous and grass spoilage by 'poaching' would be a serious matter.

Instead the grass crop is harvested by a silage harvester, attached to a 'Power Major', mounted on half-tracks with side extensions fitted to the front wheels and a silage trailer, also mounted on crawler tracks. A number of these units bring in the wilted grass to the factory, where it is chopped into short lengths, dried in a peat-fired rotary drier and then pulverised to a dry powder compounded with mineral nutrients and vitamins and sold in pelleted form as a 'horse conditioner' or as a winter feed for dairy cattle.

Grain-Drying Problems

The introduction of the combine harvester has brought new problems, although no one today would dream of returning to the sickle and sheaf-drying. With the combine it is generally necessary to dry the grain before it can be safely stored, because the corn is threshed immediately it is cut and there is no period of air- or sun-drying. This can be an advantage in wet summers, when corn stacked in sheaves used to be completely spoiled by rain.

Small quantities of grain may be dried slowly on a barbecue by sun-drying, as is done with paddy in Malaya and Thailand, but such methods are not suitable for large quantities or for grain containing an appreciable amount of moisture, as is the case with combine-harvested grain. Even for the farmer who grows grain as a sideline, some form of grain drier is an essential article of equipment.

Driers for handling grain are of various kinds and for the small farmer some form of platform drier, consisting of a heating unit and a blower to drive the heated air up through the bags of grain, arranged on a grille is all that is necessary. The advantage of this simple system is that the same unit is equally adaptable for baled hay.

There are also various types of continuous-flow and silo driers, and in-bin and in-sack driers, which are more suitable for large quantities of grain. For all of these it is essential to have instruments to measure grain moisture, air humidity and air temperatures, so that the best use is made of the heated air and to ensure that the drying is not forced.

Drying by moving air is based on its ability to pick up moisture from the moist grain. The amount of moisture which this air can pick up depends on its relative humidity. Warming air, even by a few degrees, considerably increases its power to pick up moisture, but if the air is too hot the surface extraction of moisture is so great that moisture cannot diffuse from the inside of each grain, the result can be that the individual grains are scorched through over-drying, while within they are under-dried and moist. This phenomenon is known as 'case-hardening'.

The Great Potato Famine

IRISH POLITICAL HISTORY has materially influenced the progress of agriculture in Ireland. Confiscation of land to make larger farms, penal enactments on squatters, absentee landlordism, land-holding restrictions, an explosive increase in population and large-scale emigration to foreign parts have all combined to produce a story which today makes painful reading.

But the story of the Great Potato Famine has to be considered in relation to the times. The same conditions of landlordism prevailed in Britain following the Act of Enclosures and widespread potato disease outbreaks also frequently occurred in the wetter parts of the country, though they were nothing like as serious as in the wetter parts of Ireland.

Over in Ireland, the Government of the day imported maize and established soup kitchens, but they also allowed private trading to go on without any of the controls which we would think nothing of today. They permitted the continued export of Irish corn and

cattle and allowed uncontrolled speculation in food supplies.

It has to be remembered, too, that the extreme west of Ireland in those days was a very long way away—there were no aeroplanes to drop food supplies and no railways; the roads were quagmires and there were no safe ports on this stormy coast. There was no radio communication and no telegraph, and there was not even a postal service and no newspapers to advertise the disaster.

In the Great Potato Famine of 1845-49 well over a million people died of starvation and a million people were forced to leave their homes and emigrate to England, Scotland, Australia and the New World owing to the failure of the potato crop, on which the Irish people so largely depended. We have been told tragic stories of people being found dead with grass stuffed in their mouths and of the grassy mounds which mark the sites of mass graves.

It needs little imagination to picture the streams of refugees struggling over the unmade roads of the Central Plain of Ireland to Dublin, seeking what they could devour and finding little to eat in the barren peat areas through which they passed, with the weak, the aged and the infirm falling and dying through undernourishment and total exhaustion in these awful quagmires, as, indeed, happened on the escape route from Burma during the last war.

Control of Potato Disease

This disastrous crop failure was due to the disease *Phytophthora infestans*, and the improvement of the potato really dates from the years of the Great Famine. Determined efforts have since been made to find new varieties with immunity from the disease, so far with little success.

Modern science has not been able to suggest any better means for controlling the fungus than the use of certified seed, the burning of the potato tops, or haulms, so as to destroy the spores of the disease, the adoption of a system of crop rotations to give the land time to recover from infections, the system of early blight warnings based on meteorological observations and controlling the fungus by spraying the crop with Bordeaux or Burgundy mixtures or improved formulations containing copper.

Weed Control by Law

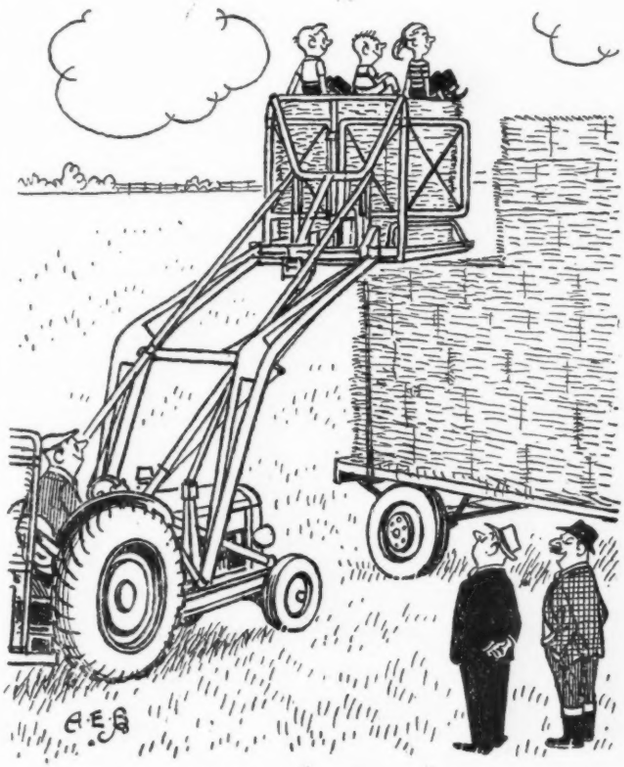
Happily, from the beginning of this century Irish agriculture began to take a turn for the better with the establishment of a Department of Agriculture, the spread of the principles of co-operation, and the reorganisation of the system of land tenure.

Ireland possesses a soil which is naturally fertile, though the excessive moisture in the west is hostile to cereal crops and potatoes, and this tends to make horse and cattle raising and milk and butter production the leading agricultural industries. But horticulture now appears to be coming into its own and the experiments which are being carried out by *Bord na Mona*—the Irish Peat Board—and the large-scale trials by the Irish Sugar Co., both on the hitherto infertile peat soils, are showing remarkable results.

One aspect of Irish agriculture is indeed 'Irish': it is the system of weed control by penal legislation. At every police station throughout the land there are orders of banishment on five well-known weeds, which appear to be flourishing all the better for being outlawed. Penal enactments against pests and pernicious weeds have been promulgated in other countries and they have never, in our experience, been very effective, and, judging by the condition of the fields and hedges, these 'banishment orders' do not appear to be working in Ireland.

What is wanted is the immediate introduction of an organised system of mechanical and chemical weed control. We use the word 'organised' advisedly because modern methods of weed control are so far removed from the age-old systems of farming and are so scientific that great harm could be done by recommending the use of agricultural chemicals by all and sundry.

Here, as in Britain, is to be found the makings of several new industries and the creation of employment, not only to carry out these modern methods of weed control, but also to deal with the extra yields of agricultural produce which will follow as a direct outcome of the eradication of the pernicious and even cattle-poisoning weeds.



'The last load, old boy—an old custom, you know'

What is wanted is a national panel of trained and qualified contractors to clean up the pastures, improve the drainage of rush-covered fields and reduce the overgrown tree-high hedges which are seriously invading and reducing the fields.

In the first instance, it will be necessary to import supplies of agricultural chemicals and agricultural machinery, but later on firms could be induced to establish factories in Ireland on the foundation of the knowledge and experience they have accumulated during the last 15 years and the mistakes and successes which are incidental to scientific progress and research.

This Month's Cover Picture

Boron deficiency has proved to be a cause of serious economic loss in citrus in a number of countries and the symptoms have been well described by Professor Chapman, of California, as follows[1]:

'Lack of this element shows up in a variety of fruit, foliar and growth conditions. The most prominent symptom is the production of hard, misshapen fruit which show brownish or blackish spots or streaks in the white albedo of the rind and sometimes brownish gum deposits in the fleshy part of the fruit. Defoliation, especially marked in the spring at bloom time, abortion of young terminal growth, initiation of new growth which never matures, multiple buds, die-back of twigs, curling of leaves and corking of the veins of the leaves are all symptoms of boron deficiency. Gumming of twigs and branches and a wilted appearance of the tree, when soil moisture is not lacking, are other manifestations'.

Poor growth of trees and excessive abortion of young fruit naturally result in reduced yields; but the effects on quality of the produce are of even greater significance. Not only is the appearance unsightly, but juice percentage and sugar content are lowered, thus rendering the fruit less suitable for processing.

Fortunately the correction of boron deficiency, once diagnosed, is relatively simple either by soil application of High Grade Fertiliser Borate, the use of a boronated fertiliser, or a foliar spray of SOLUBOR in early spring.

1. H. D. Chapman: *The Cultivation of Citrus Soils*, WORLD CROPS, July 1959.

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Advertiser's Announcement

Water for Tea

THE SEVERE DROUGHT experienced in North-East India during the early part of 1960 had serious consequences for the tea industry and growers in the drier areas are now seriously considering the provision of artificial rain for this valuable crop, this being a more economical and effective way of using water than ordinary ditch irrigation.

In a previous issue (WORLD CROPS, 1959, **11**, 207) T. E. Rogers concluded that in areas which are subject to drought yields can be materially increased by overhead irrigation. The cost is considerable, but the results showed that the expenditure was more than justified.

In tea-growing areas where the rainfall distribution is more favourable or where droughts occur only at very infrequent intervals, it has been concluded by H. Ferguson, N. G. Gokhale and P. M. Glover in India that irrigation would not be a paying proposition.

In the present issue of WORLD CROPS Major J. S. Stower has taken the matter a stage further. He considers the water requirements and recommends the most suitable type of equipment for sending artificial rain over tea bushes provided with shade.

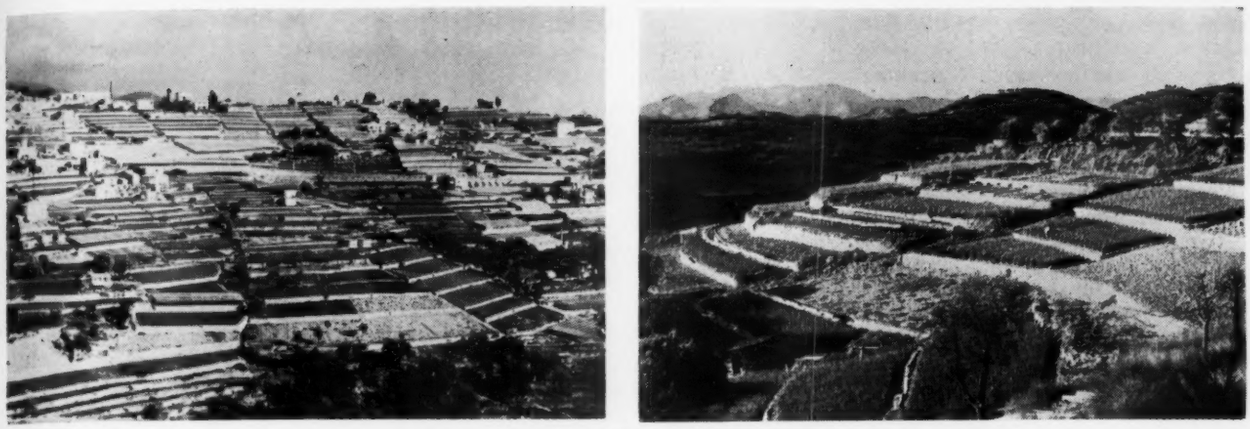
Stimulants even for Rubber

AT THE NATURAL RUBBER RESEARCH CONFERENCE held in Kuala Lumpur last autumn Prof. Blackman spoke on 'The Stimulation of Latex Flow by Plant-growth Regulators' and, according to the report, he traced the history of the development of successful yield stimulant mixtures which increase the flow of latex after tapping, showing how this had been dependent on fundamental research into the activities of plant-growth substances.

It had been estimated that several million pounds' worth of additional rubber had been produced in Malaya during the past four years by the use of such stimulants. Prof. Blackman made it clear that there was still much to be learnt about the exact mechanism of this yield stimulation process and it has now been made the subject of active research.

Correction

In the September 1961 issue of WORLD CROPS it was stated that 'the total forest area of North Vietnam (formerly part of French Indo-China) was about 22 million acres and the total volume of standing timber was 1.5 million cu. m.', whereas the correct figure should be '1,500 million cu. m.'



Broad-terraced gardens on the foothills showing the intensity of cultivation

More Water

Meeting the Requirements of Italian Agriculture

D. WOOD, A.R.S.M., F.G.S., A.M.I.P.

An article entitled 'Give the Thirsty Earth a Drink' was recently published in an Italian magazine, L'Europeo. *The article, by a distinguished economist, Epicarmo Corbino, called attention to the inter-relationship of economics and hydrology in agricultural development projects.*

THE first obstacle to agricultural progress is the mountainous character of much of Italy. Some 70% of the country is covered by mountains and hills; the plains constituting the remaining land surface of the peninsula and the islands are the principal agricultural areas. These are steadily being encroached upon and reduced by the sprawling growth of cities and the establishment of new towns and industrial zones. The lower fertility of the land at higher altitudes is aggravated by the rugged mountain structure and by its climate.

Lost for ever

Rainfall, largely restricted to winter months, is nowhere high, though it is in the mountains that it is heaviest. The orogeny* is such that precipitation on these mountains rapidly traverses the beds of torrents, making its way over the few plains or passing directly into the sea, which is nowhere, except near the northern frontiers, more than 60 miles away. Thus water which could provide irrigation is lost for ever.

Corbino in his article first stresses the disadvantages of the natural features to the welfare of the people, particularly in the south, where watercourses are often dry during the middle of the year, when water could be of most benefit to agriculture. He also makes the pessimistic assertion that the possibilities of irrigation in the higher areas are non-existent or very much reduced, but recent research indicates grounds for a more optimistic view. Even a small percentage increase in irrigable land could provide a valuable new asset in any country where agriculture is a leading industry.

Need for water conservation

Corbino's second theme is the other natural disadvantage of the country, for Italy can really be placed in the category of semi-arid lands. He points out that the total flow of water in all rivers and torrents of the south does not amount to the flow of even one of the large rivers of the north. This should stimulate enquiry into the destination of rainfall in Central and Southern Italy and into the best means of conserving it.

Attempts to meet these misfortunes by artificial means are his third subject. Here he finds ready targets for criticism and he does not fail to point out the very considerable costs of man-made reservoirs, as reflected in irrigation costs per acre.

He adds a warning note on the possible complete waste of such capital investment, since the silting-up of these reservoirs is a natural concomitant of many of the sites most suitable for such works. Reservoirs already constructed can be seen which, after only a few decades, are nearly filled with sediment brought down from the high mountains by the torrents and rivers which feed them.

More tube wells needed

Corbino's final theme is a constructive proposal to which the foregoing are the preface. He thinks that a better solution for the extension of irrigated agriculture may be found by drilling

* Orogenesis: a phase in the building of mountains during which the accumulated sediments are compressed, giving rise to folds and faults.

more tube wells to develop sub-surface water supplies. His most interesting and constructive proposal is that the price of electric current to pump wells should be reduced.

Costs of electric current in Italy are high. The writer recently visited a small estate where daily pumping costs for irrigation were said to be over 100,000 lire per day. If Government expenditure were to be diverted from the construction of reservoirs in the mountains to subsidising electric power for irrigation by tube wells, very practical benefits would result in a fraction of the time necessary for the planning and construction of major engineering projects for storing surface water behind dams.

As one with many years of experience in many countries in the development of sub-surface waters for agriculture and other purposes, the writer offers his congratulations to Epicarmo Corbino for his timely and much needed article. It is against a background of the four last years of special and practical research in Italy that he ventures to offer the following specialised contributions to the themes of this distinguished author.

Rotary drilled well in hard-fissured limestone treated with 3 tons of hydrochloric acid with 700 lb. of solid carbon dioxide added. The well is capped and the immense pressure so generated drives the acid far into the fissures, enlarging them and breaking through to other fissures. This treatment increased production by 25%; increases of 80% are not uncommon. The photograph was taken as the pressure was released

Terraced gardens

The orogeny and climate of the country cannot be altered, but we may at least look for some means of ameliorating the disabilities which they bring about. There must be many mountainous and hilly areas which are quite suitable for irrigated agriculture if only water can be provided, for steep slopes do not necessarily prevent cultivation.

One can instance the Andes in Peru, so extensively terraced and cultivated by the Inca† civilisation of past centuries; even today the slopes of Italy's mountains provide many examples. The mountain slopes around the Bay of Naples, too, come to mind: there is the *Riviera dei Fiori*, where still more slopes could be cultivated if only sub-surface sources of water as yet unexploited were tested and developed.

Conservation in the mountains

The country's water supply is derived from rains and snows mostly in the mountain areas, and it is largely restricted to the winter months. What happens to it? Some passes into the ground and enters permeable rock; some flows in the beds of torrents and rivers to the sea, where it is lost; and some contributes to the recharge of aquifers‡ formed by gravels and conoids at the foot of the mountains or by the shallow permeable sediments covering the plains; yet a fourth portion is used by plants or is lost by evaporation.

It is the portion soaking into the ground and percolating pervious rocks which is of interest. What happens to it? Where its underground movement is restricted it simply keeps the porous portion of the rock filled with water and, unless this water is abstracted, no further water can enter these rocks; the excess simply runs away in surface channels to the sea and is lost entirely.

Where, as may be more usual, communicating fissures in the rocks or interstices between grains of sand permit free, if slow and intricate, passage of water, it moves slowly from the higher levels, where it entered the rocks, towards the sea. There, at many points around the coast, it is seen to be released from beneath the sea bed and to mingle with the salt water—again a loss to the nation.

It is to the interruption of this movement of ground water and its capture and lifting to the surface for agricultural use that thought and effort should be directed. In the mountains little work has been done on this problem. Yet it is here that permeable rocks—elsewhere covered by many hundreds of feet of less permeable or impermeable rocks — have been brought to the surface by geological upheavals. They can and do receive a portion of the rainfall and store it in their fissures, cavities and interstices, or they provide a slow and tortuous subterranean passage for it to the sea.

Storage in permeable rock

Unfortunately large tracts of Italy's mountains expose only the impermeable rocks, but there are sufficiently large expanses of permeable rocks to absorb great quantities of water and, where not exposed, these permeable rocks may in places lie at no great distance below their impermeable cover.

† Inca civilisation: the 300 years before the Spanish conquest of Peru in 1529.

‡ Aquifer: ground stratum which carries water.

The writer has recently had an opportunity of testing such theories by drilling wells in suitable mountain localities; they are now demonstrably correct. It is perhaps a valid generalisation that the more mountainous the area the more certain are the prospects of finding sub-surface water.

Recent drilling has also demonstrated that certain strata of the Italian geological sequence, by their nature unfavourable to the storage of water, can form good aquifers where they have been subjected to the intense folding and fracturing associated with the structure of the Appennines.

Now that practical tests have placed such hypotheses beyond the region of speculation, it can be seen that there is more hope than was supposed for establishing irrigated agriculture in the less favourable or unfavourable 70% of the land surface of Italy.

Sub-surface water resources

Wells drilled in the mountains can be used to irrigate land in their vicinity or water can fall by gravity or be led by pipeline or canal to more distant areas where the soil and topography are more favourable to irrigated agriculture. Water from these wells need only be flowing or used as and when required. At other times it can remain stored beneath the ground, safe from evaporation losses and ready for use whenever the pump is again operated. Wells with water flowing under artesian head are also not unknown in the mountains.

Why has little or nothing been done to develop the use of this underground wealth of Italy? There are, no doubt, a number of reasons why such a solution for agricultural expansion has not been sought in the mountains, whilst in the plains are some of the most intensively drilled areas in the world. One reason may be the Italian genius for dam construction which has obscured the importance of the sub-surface water resources.

The large hydro-electric projects which are to be found among the mountains are impressive witnesses to Italian engineering skill, but there are few examples of sub-surface water development. It would seem that the services of the able Italian hydro-geologist are rarely sought for such schemes. Nor, with the lack of demand for these undertakings, has the Italian drilling industry had to face up to the special requirements and problems which sub-surface water development in the mountains entails.

High cost of electricity

Perhaps the greatest deterrent to ground-water development for agriculture is the high cost of electric power for lifting water to the surface. Corbino's suggestion of a subsidy should open up a large field of sub-surface water research and, by irrigation, increase substantially the amount of land which is cultivable. Indeed, comparatively small areas which are irrigable can grow very valuable crops and be less subject to the hazards of climatic eccentricities.

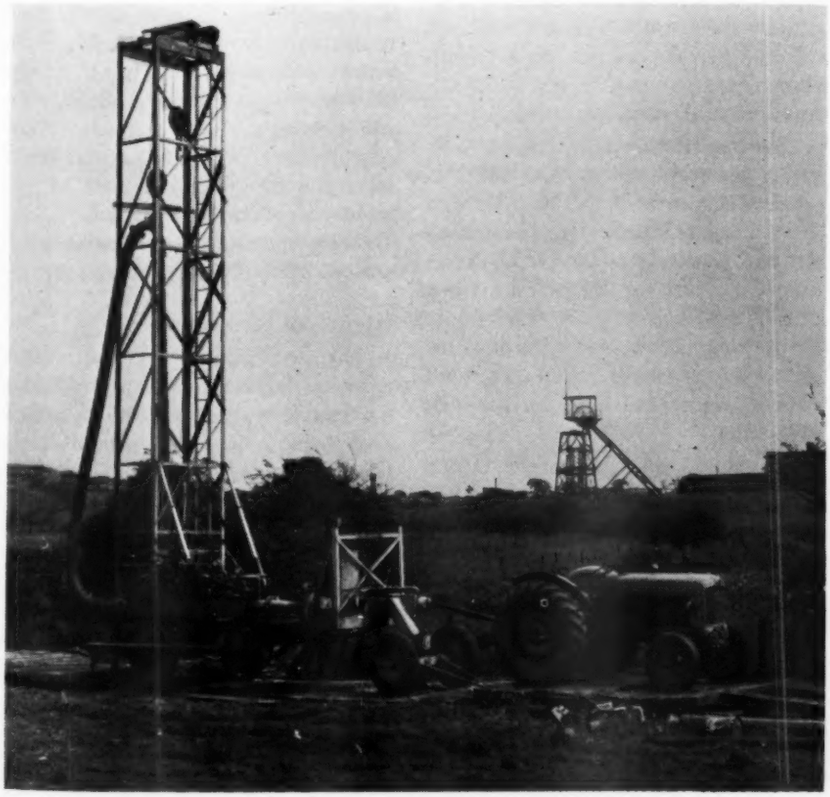
Erratic water supplies

These underground stores of water, if drawn upon, have to be replenished during the following rainy season. Investigations to determine the correct balance between extraction and recharge should be undertaken. This reintroduces the second national disadvantage instanced in the article under review—that of irregular and low average rates of flow of the rivers in the south.

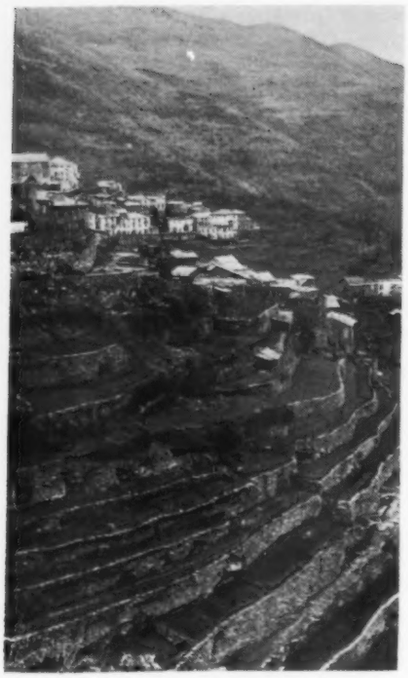
The results of some of the attempts to arrest the wastage of seasonal rains in these short rivers by the construction of a number of dams in their courses can be observed in many places. The small reservoir in the river bed to which a dam gives rise becomes rapidly filled with the erosional products of the river and its tributaries and the reservoir ceases to exist. The *lago di Quarto* in Romagna is an example of such a disaster befalling a very large reservoir.

Whilst the cause of the wastage cannot be eliminated, the wastage itself can be reduced. If underground stores of water are tapped by wells and some of the water is extracted, space is left for replacement by further surface water. So where the wasteful streams cross permeable rocks they can contribute to the recharge of underground reservoirs. This water thus becomes a valuable asset instead of running away to the sea.

Water, unlike minerals which are mined, is not a wasting asset. As fast as it is removed from the earth it is replaced by succeeding rains—providing it is extracted and a proper ratio between extraction and recharge is maintained.



Hydraulically-powered, reverse-circulation rotary rig at work



A hill-top town in Italy with every inch of ground terraced

Losses from reservoirs and channels

Corbino's criticism of the construction of artificial reservoirs as a panacea for water shortage is timely, and Italy is not the only country where such criticism could do good. He does no disservice to the agricultural economy of Italy by pointing out the great cost of such projects and the grave danger that natural causes may fill these reservoirs with sediment, render them useless in a few decades and result in the wastage of hundreds of milliards of lire.

Whatever the ultimate fate of a reservoir may be, it is probable that at least 30% of the water impounded by a dam will be lost by evaporation and yet a further loss will be attributable to soakage into the containing rocks. Losses in canals and channels distributing the water, both from evaporation and seepage, will also have to be faced. The net result is that a third of the capital expended on a project to impound an adequate supply of water will have been wasted and will give no return.

Still another disadvantage of these dam projects is that they normally require several years for their planning and construction. There is no interim benefit. Until the dam is complete, until one or more wet seasons to fill the reservoir have elapsed, until the last length of pipeline has been laid or until the last metre of canal has been constructed not one drop of water can reach its destined place of consumption.

Speed, cheapness and efficiency

Corbino indicates the correct solution—irrigation by water obtained from tube wells. This is feasible where the agricultural area overlies water-bearing rocks or where sub-surface water sources can be developed by drilling into water-bearing rocks at no great distance from the cultivable land to which the water can be brought by canal or, preferably and without evaporation losses, by pipeline. It is a policy of despair to accept an unsupported assertion that underground water does not exist.

The definition of areas where sub-surface water does not exist will, in most cases, have to be decided by a proper study of the geology of the region, supported by exploratory drilling. Once the locality, quantity and quality of sub-surface water have been determined the next step, the siting and construction of suitable wells for its development, is merely a technical matter—the costs can be fairly assessed and the best system of development can be selected.

Agricultural development

One outstanding advantage of irrigating by a system of tube wells, as opposed to surface reservoirs, is that as soon as one tube well has been constructed its water can be put to immediate use for irrigation. So a project can begin to yield results only a few days after it has started. Progressively as more wells are constructed, more and more land can be irrigated.

It follows, too, that all the capital needed for a project need not be available at the start. Thus there is no need to postpone a scheme indefinitely because adequate capital is not available.

Calculations, based on statistics for very large tube-well irrigation schemes in India, show that in rather less than two years the value of the crops grown equals the capital expenditure on the wells and on the power stations energising their pumps.

Terraced gardens in the mountains of Italy

Salinity

One objection to sub-surface waters which is sometimes put forward is that they contain more salts in solution than surface waters. This can be true in a few cases where ground water is percolating rocks with soluble fractions. But rivers also flow over such rocks or are derived from springs emerging from them and evaporation will increase the saline content of these mixed waters. As an example, water from the Blue Nile, after traversing hundreds of miles of canals to the Gezireh cotton lands, is notably increased in salinity by evaporation.

High cost of reservoirs

The principal objection raised against tube-well irrigation schemes is that, unlike a reservoir with its gravity feed to the point of consumption, the tube-well water must be pumped to surface. These pumping costs are usually asserted to be completely absent from a dam and reservoir project.

There are, however, other costs in a reservoir project which are seldom appreciated. There must be some maintenance costs of the dam and its surroundings; there are considerable maintenance costs of the canals, particularly to keep them free from weeds and algae; there are constant losses

by evaporation; and there is the interest on the large capital sum of money for the reservoir dam and canals, which alone can exceed the cost of the tube wells for a comparable supply of water.

To this last objection—an objection never to be accepted without a true comparative assessment of the costs—Corbino's solution of a Government subsidy for the electric power consumed by the tube-well pumps offers the perfect answer. Undoubtedly a lower cost for electric power would prove a powerful stimulant to the development of subterranean water sources.

PREVIOUS ARTICLES

1. June 1958, 209: 'The Provision of Water for Irrigation'.
2. June 1959, 215: 'Water for Irrigation'.
3. April 1960, 133: 'Water for Irrigation in the Po Valley'.
4. *L'Europeo*, 12 March, 1961: E. Corbino, 'Dar da bere alla terra assetata'.

The Lago di Quarto in the Central Apennines—an artificial reservoir now almost entirely filled with sediment brought down by its tributary

Roots in Danger

A 16-mm. sound film in colour, running for 18 min. 1961. Produced by the Shell Film Unit.

'Roots in Danger' is a short film about plant nematodes, the damage they do and the means of controlling them. It shows how patchy crops, stunted and wilting plants and reduced yields are often attributed by the farmer to 'soil sickness' because he can find no visible pest, whereas in many cases these symptoms are due to the presence of microscopic plant parasitic nematodes in the soil.

The first half of the film, shot in different parts of the world, describes the pests and shows how plants are damaged by them; for this reason it is likely to be of interest academically as well as for its practical value in crop protection.

While crop rotation may be possible with field crops, and steam sterilisation can be used in glasshouses to reduce losses by nematode damage, 'Roots in Danger' shows that chemical control of nematodes with soil fumigants is often the most effective and economic method. The film deals with the two *Shell* soil fumigants, 'D-D' and 'Nemagon'. 'D-D' is recommended as a pre-planting treatment for annual and perennial crops in temperate and tropical climates. 'Nemagon', which requires a higher soil temperature than 'D-D' to be effective, is recommended for outdoor application in warm countries and for glasshouse use in temperate areas; its great advantage is that, correctly used, it is non-toxic to a great many plants and can therefore be applied at the time of planting and on established crops.

Among the crops illustrated are annuals such as cotton, tobacco and tomatoes, which are often grown on the same land in successive years, and plantation crops such as citrus, bananas and pineapples.

Tobacco Consumption

In 1955 Rhodesia supplied about 21½% of the tobacco in the average cigarette smoked in Britain. Last year the percentage was 27½ and there is every possibility that by 1965 Rhodesia will supply about 35%.

Irrigation Scheme

A £3 million irrigation scheme for 366,000 small farmer families in the native reserves will perhaps do more to improve the conditions of life for more than a million people than any other single measure, according to Dr. J. W. Rowland, of the Henderson Research Station, Southern Rhodesia, at the 10-day Africa and Irrigation Conference recently held in Salisbury and attended by 180 delegates from 10 countries.

This conference was sponsored by a British company, *Wright Rain Ltd.*, and its associate company in Southern Rhodesia, *Wright Rain Africa (Pvt.) Ltd.*

The company has since been asked to install one or two pilot schemes in 1962 using pumps driven by electric, petrol and diesel motors to bring water from the rivers, boreholes and deep wells.

Each garden in the pilot scheme is to be provided with a sprinkler, so that the family will be able to grow green vegetables, potatoes, lucerne and even a little wheat, to maintain fruit trees and provide green feed for livestock using the minimum of water and making the best use of that water.

The Old Way . . . *Traditional ploughing with teams of bullocks is uneven and tufty, resulting in poor weed control and low yields*

From Bullock to Tractor

In One Stage or Two?

RAY WIJEWARDENE, B.A.(MECH. SC.), M.A.(CANTAB.), M.A.S.A.E., A.M.I.B.A.E., M.I.E.C.

IT is easy to be wise after the event, but an analysis of the reasons for previous failures has provided useful indications leading to a more rational approach to, and a better appreciation of, the eventual inevitability of mechanisation in these hitherto lesser developed countries.

Junk yards piled high with derelict agricultural machinery all over the South-East Asian countries are mute and bitter evidence of misguided efforts to change, in one stage, an agriculture based entirely on manual power and draught animals into one incorporating the latest advances in mechanised farming in Western countries.

Analysis of the situation

1. The capital cost of each unit of tractor and its auxiliary implements was so considerable in relation to the number of small (under 35-acre average) scattered farms to be served that a heavy investment had to be spread thinly over too wide an area. Thus too few farmers could make use of the services of the tractor during the brief periods when agro-climatic conditions were suitable for cultivation; the position was further aggravated by the excessive time needing to be spent in movement from one postage-stamp-sized farm to another.

2. In hiring a tractor the farmer had to become an observer, on his own land, of someone else cultivating his land for him, as is also true in the case of communes. Furthermore, he had to hire not only the tractor, but the operator as well!

3. Even in the Western countries less than a third of the working life of a tractor is spent in cultivation operations; the remainder is occupied with transportation on the farm. Asian countries which rely mainly on monsoons to produce the brief periods when soils are suitable for cultivation have to cope with even longer spells when no cultivation at all can be done. During these long dry months there is no real necessity to utilise the quicker transport facilities of the tractor-trailer from the pool as against the farmer's own bullock-drawn cart.

The inevitable result has been that the large investment in tractors and the large staff of operating and maintenance personnel at every tractor pool remained idle during the greater part of the year, interspersed with brief periods of intense activity. No operation can remain economical under such fluctuating conditions of employment and demand.

4. In no case has the farmer been able to dispose of his work animals and so utilise, for his own needs, the land upon which his cattle grazed. He had to retain them in case, as frequently happened, the tractor was not able to reach him in time or broke down in the course of its rushed and widely scattered duties. He also required his bullock and cart for transport during the long, dry season.

Need for mechanisation

Without doubt the tractor has a very definite place in Asian agriculture where the sizes of the farms or plantations are large enough to warrant its

full-time, economic utilisation. These larger farms, however, are only a minute fraction of the total; thus only the fringe of the mechanisation potential of the lesser developed countries has been, or can be, tapped by the tractor. So what of the overwhelming majority of farms in these countries which cultivate less than 35 acres each season?

Certainly, where the property is under 5 acres the farmer is better off with his oxen than with machinery. But for holdings between 5 and 35 acres (these limits cover by far the greatest percentage of Asian farms) the farmer, limited mainly by what he and his oxen can accomplish, cannot cope with the situation. He has therefore to employ additional teams of oxen and ploughmen, each of whom will, with the farmer, obtain only a marginal existence out of the few acres they till.

There is certainly an urgent need for mechanisation to fill the gap between the bullock and the tractor. Necessity has always been the mother of invention and in the East there has developed the use of the ' power tiller ', which constitutes the most practical solution yet devised to meet this need.

and the New . . . *Mr. Chang, an agricultural graduate in Malaya, puddles his field with a 'Landmaster 150' prior to transplanting his rice seedlings into it*

Maid-of-all-work

Although available in Western countries for many years, particularly for market garden use, earlier versions of the power tiller proved unsuccessful in their application to tropical farming for the reason that most of these machines were too heavy and cumbersome and hopelessly unsuited to tropical crops, soils and weather; they were also a costly investment to perform only one operation—usually rotary cultivation. Since 1957 a new concept of the power tiller has swept across these countries and has quickly earned for itself a very definite place on the farms of both tropical and temperate Asia by meeting the need for a really practical mechanical aid midway between the bullock and the tractor.

East Pakistan. A farmer inter-cultivates his young bananas, planted at 45-in. intervals, using a power tiller

Appeal of the power tiller

1. Power tillers are low-priced machines with costs comparable with those of the bullock—in some areas costing as much as one team of bullocks (where draught animals are scarce) and in others about the same as the price of two teams.

2. They are versatile and can perform a great many cultivation operations on the farm, such as ploughing, harrowing, tilling, seeding and inter-row cultivation, in addition to the special requirements of the paddy farmers, *viz.* puddling and levelling the rice fields. They are also easily and quickly adapted to a wide range of off-season uses, such as transporting, harvesting, threshing, pumping and weed slashing or mulching.

3. They have been designed specifically to meet the requirements of tropical crops on relatively small tropical and sub-tropical farms; a far cry, indeed, from the type of machinery developed for a completely different agricultural economy.

4. They are designed to be used by the Asian farmer himself—a man who is less mechanically-minded than his counterpart in the West. They are simple to operate, have a minimum of controls and require little or no maintenance.

Nowhere in the world does the true farmer wish to spend time fiddling with machinery when he should be cultivating his crop, but this applies particularly to the farmer in the lesser developed countries. A special point is that the power tiller handles and feels very similar to the ox-drawn equipment with which the farmer is

Thailand. A rapid change over from one market-garden crop to another is possible by 'once-over' preparation of the land.

Ceylon. A farmer ploughing his field with a 'Landmaster 150' is turning an even furrow on his wet rice field and obtains good control of weeds by inversion

already acquainted; thus it is no problem for him to become a convert to the new mechanisation.

5. The power tiller enables the farmer to farm his land better, more economically and quicker than he has hitherto been able in view of the limitations of his traditional bullock-drawn implements. The improved quality of his cultivation has invariably resulted in less weed competition, higher yields and so enhanced income.

Back to the land

Of particular interest is the greater affluence which is developing in farming areas which have adopted and adapted themselves to the power tiller.

The farmers are obviously better dressed, their families better fed, their children better educated and their houses better built. *Perhaps the most encouraging feature of the new mechanisation is the return of the educated young man to the land.*

The farmer now finds farming both mentally and financially as satisfying and rewarding as clerical work or any other skilled trade to which he might otherwise have been drawn in the town. Working with a machine designed to suit his purse and his land has given him a rise in social status to which the youth of today, in whatever part of the world they may be, aspire.

Fertilisers and Food

Two regional representatives have been appointed to serve the FAO Fertiliser Programme: Dr. F. W. Hauck, a German fertiliser use expert, as regional soil fertility specialist in West Africa, and M. Mathieu, a French soil fertility and extension expert, for the Near East. They will be working in close contact with the FAO regional offices in Accra and Cairo. A third appointment is shortly expected for northern Latin America.

As previously reported, this fertiliser programme is being financed by the world fertiliser industry over a five-year period, during which an extensive programme of field demonstrations and trials is to be carried out in various countries (WORLD CROPS, 1961, 13, 153 and 220).

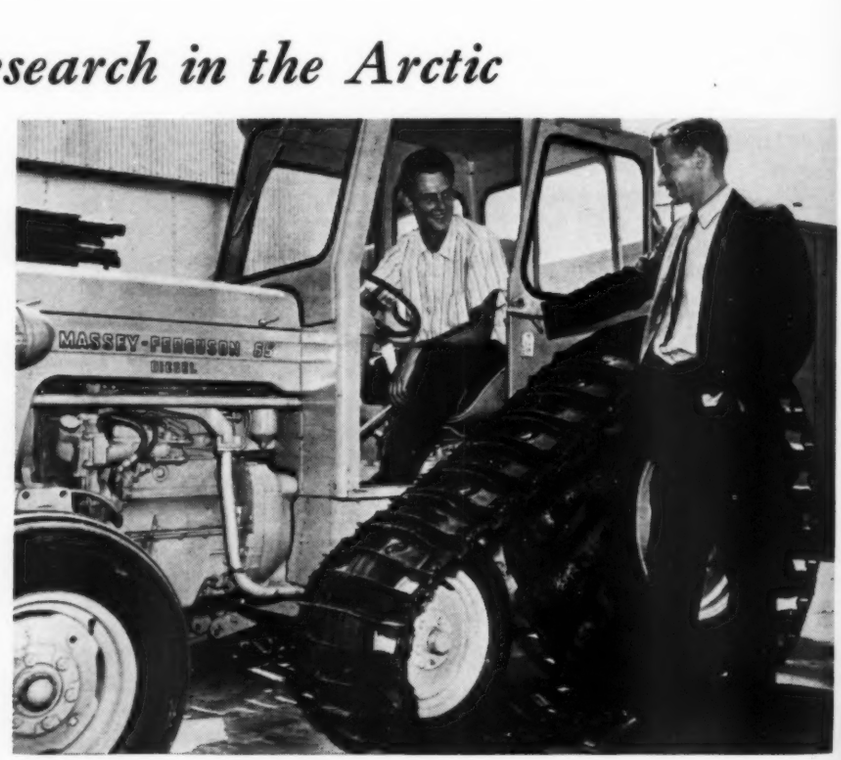
H.Q. Moved

The headquarters of the Department of Industrial and Scientific Research has been moved from Charles House, Regent Street, to State House, High Holborn, London, W.C.1.

Research in the Arctic

Two Perkins-engined tractors started as soon as fully-charged batteries were installed after being left standing in the open all winter on ice-clad Devon Island, lat. 75°N, 600 miles within the Arctic Circle. The tractors—both *Massey-Ferguson* '65' models fitted with special cabs and heavy-duty tracks—were presented last year to a research mission sponsored by the Arctic Institute of North America to study animal and plant life and ice movements.

They were left behind when the expedition left to winter in a warmer climate. During the winter the tractors, powered by four-cylinder diesel engines, had been exposed to blizzards and temperatures reaching to 67° below zero.



Right: *One of the tractors sent to Devon Island*

Storage of Crops in the Tropics

The Design and Construction of Stores

W. H. RANSOM*

Both biological and constructional problems must be solved before successful storage of tropical crops is assured. Their solution depends primarily upon (1) the nature of the crop; (2) the length of storage required; and (3) the prevailing climate. The entomologist and mycologist have to decide the optimum surrounding atmospheric conditions for successful storage, the builder and storage officer should ensure that stores are so constructed that these conditions can be fulfilled.

STORED crops deteriorate mainly through attack by insects and micro-organisms. Larger pests, such as rodents and birds, may also cause damage and loss. Deterioration can be prevented or reduced by: (1) proofing the store against large vermin; (2) killing small pests by fumigation, by the use of contact insecticides, or by asphyxiation; (3) controlling moisture; and (4) controlling temperature.

Protection from large vermin

Rats, mice, birds and other destructive creatures may damage a crop by feeding upon it or by contaminating it, or may cause indirect loss by damaging storage sacks. They harbour in cavities, particularly those between walls, between ceilings and floors, and in stud partitions. Good building design will do much to prevent infestation and attack. Cavity walls should be sealed with a solid material, *e.g.* cement-sand grout, bricks, sheet metal, particularly to prevent the entry of birds. All pipes, shafts and ducts should be sealed against entry and external pipes fitted with metal cowls projecting at least 9 in. from the pipe to deter climbing rodents. Partition walls should be of solid construction and well sealed to the main walls.

Control of smaller pests

Smaller vermin and insects harbour in cracks and crevices. A store, simple in design, with smooth internal surfaces and without unnecessary internal projections is, therefore, desirable. A curved floor-to-wall intersection is beneficial, as it enables spilt material—which would encourage infestation—to be easily removed.

Insects, their larvae and their eggs are commonly destroyed by fumigation. It is desirable, therefore, to construct stores that may be easily sealed. This is more readily accomplished when walls and roof are of solidly-jointed material, *e.g.* concrete block and reinforced concrete, than when they are of corrugated sheeting. In the latter case the gaps between adjacent wall sheets and at the roof-wall intersection will clearly allow fumigant to escape readily and will also permit reinfestation after fumigation. For the same reasons, permanent ventilation is undesirable; any ventilation grids provided should be controllable and capable of being tightly closed.

When infested produce is stored the living insects, at all stages of their life cycle, consume oxygen and produce carbon dioxide in the process. In an air-tight store this depletion of oxygen and increase of carbon dioxide serves to inhibit further development and eventually the insects present will die. While it may be possible to seal

Photos: Tropical Building Studies No. 2

W. Indies. Undesirable permanent ventilation at the eaves of a corrugated steel warehouse in an area of high humidity

* Building Research Station, Watford, England.

Cyprus. Circular pit silo of concrete which is continued underground

an existing store sufficiently for fumigation to be performed successfully, requirements are much more stringent if crops are to be stored in hermetically-sealed buildings. Such buildings require special design and construction and ordinary structures cannot usually be satisfactorily adapted.

Factor of moisture

Biological activity will occur only in the presence of moisture, but this need not be present in liquid form. Thus fungi growth is rapid between 80-95% relative humidity, though it is slow below 70% R.H. The moisture content of the stored crop is very important in determining the rate of biological attack. The overall deterioration of initially dry material, even when stored under conditions of high relative humidity, can be slow. This is because some time is needed for water to be absorbed in the large amounts required to cause any appreciable rise in moisture content in the centre of a large bulk.

However, high relative humidity should be avoided, for a slight drop in temperature may then be sufficient to cause moisture to be deposited on the crop, as, for example, in the humid tropics at night. This can cause the moisture content of the crop to increase, locally, to a dangerous level. The risk of fungal attack then becomes greater and can lead to heating and caking of the grain.

Moulding and caking can also occur through moisture migration. Such a migration results when the crop is heated unevenly, such as through the metabolism of colonies of insects living in the crop or when changes in temperature in the store are great due to its construction and the weather.

Moisture in stores

All stores will contain some moisture as liquid or vapour. Apart from its effect on the crop already mentioned, excessive amounts will be harmful to the actual fabric of the store. It is worth noting that a cubic yard of freshly placed brickwork or concrete cast *in situ* may contain 25 gal. of water. Where evaporation rates are low—for example, in the warm, wet regions—stores built with these and similar materials will be slow in drying out. Moisture introduced during construction, however, is not recurrent and is likely to affect conditions for only a limited period.

It is important to prevent moisture entering the store from outside. Where rainfall is high and evaporation rates low it may penetrate directly through the body of the wall. Cavity construction, rendering or external cladding will reduce the risk of rain penetration and can altogether prevent it, though rain may also penetrate through the roof.

This is particularly likely with shallow-pitched roofs in regions of high winds and heavy rain. With sheeted roofs these risks can be reduced by insistence on proper overlaps, by the use of durable washers and by using curved ridge sheets which extend a considerable distance down the slope of the roof on either side of the ridge. If necessary, corrugated sheets can be sealed at the lap joints with hot bitumen or special tapes, or special roofing sheets can be used which require no external fastenings and no external bolt holes.

Flat roofs to stores are usually of concrete. Unprotected they are seldom leak-free, for thermal, moisture and foundation movements all tend to promote cracking. They are generally covered with bitumen felt, bitumen emulsion systems or mastic asphalt. It is always advisable to shed rainwater quickly and a minimum fall of 1 in 30 is generally recommended. Movement should be allowed for by well-designed joints properly spaced. Joints at 30- to 40-ft. intervals would be appropriate in hot, dry regions where movements are large.

The ground is a natural reservoir of moisture. Except on dry, well-drained sites, floors and walls in direct contact with the ground become damp. Vapour barriers are needed to prevent the rise of water vapour.

Factor of temperature

In warm climates the prevailing air temperatures — 70-100°F — are con-

ducive to maximum biological activity. If temperatures are either raised or lowered sufficiently, pest activity is reduced even though death may not result. In practice control is sought by lowering temperature rather than by raising it.

Overall control of temperature to reduce insect attack is of limited value unless there is a substantial reduction as with refrigeration. However, it is desirable that stores should receive as little solar radiation as possible. In low latitudes more radiation falls on the east and west walls than on the north and south, and buildings that are rectangular in plan should lie with the longer axis running east-west; then the east and west walls will be the smallest in area.

The amount of radiation absorbed by a building is reduced if its external surfaces are reflecting or light-coloured. Sun shading can reduce still further the absorption of heat. In low altitudes small overhangs will shade north and south walls for most of the day. East and west walls, however, need shading by both vertical and horizontal projections. Roofs and walls can be more completely shaded by 'false' roofs or walls separated from the main structure by a cavity. This arrangement is very efficient if the cavity is well ventilated. Cavities should be wide enough to allow access for cleaning because of the inherent risk of infestation by birds, rodents and other vermin. A ceiling of high thermal resistance also helps to reduce the heat entering from above.

A store can gain much heat through windows or skylights. Glazing should be kept to the minimum area needed and should be shaded by canopies, projections or louvred shutters. Tests have shown that it is better to place shades outside the glazing rather than inside. Double glazing also reduces the heat gain. In hot, dry regions it is an advantage if stores are of high thermal capacity and ventilated thoroughly at night when the outside air is cool. Controllable louvres and fans, which can provide natural or enforced ventilation whenever required, will be desirable.

MATERIALS OF CONSTRUCTION

Site and foundation

The need for a store to be dry and free from cracks has already been shown. It is very important, therefore, to select a good site, choosing, if possible, one that is well drained, where the ground slopes away from the store and prevents water from accumulating around it. Termite-infested areas should be avoided or thoroughly poisoned.

In many tropical areas 'heaving' soils of unstable clay are found. Stores built on these soils alter the natural ground moisture equilibrium, causing moisture to migrate to the clay under the building. The clay then swells; the pressure exerted may be sufficient to force up the centre of the building, causing severe cracking. Made-up ground or filling is not a good base for foundations.

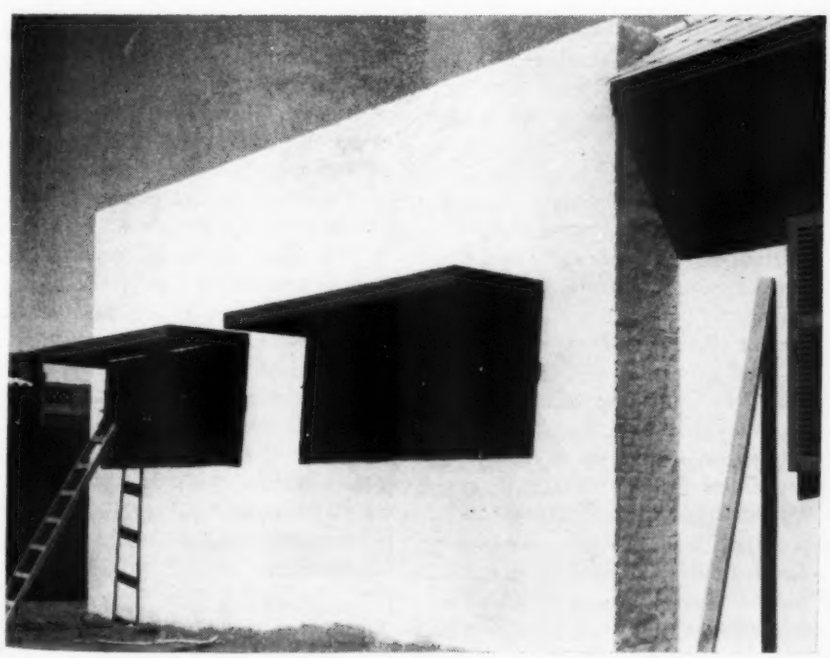
Stores need damp-proof courses and vapour barriers to prevent entry of water and water vapour. Materials used include lead, copper, bitumen felt, mastic asphalt and bitumen or coal-tar pitch poured hot to form a continuous layer not less than $\frac{1}{8}$ in. thick.

Floors

The floor of a storage building will, in general, consist of a concrete screed laid over a concrete base. It is most important to ensure that the concrete is well cured—premature drying, resulting in a lack of hydration of the cement, is a common cause of much poor concrete seen in the tropics. It should be kept damp for at least seven days, preferably by covering the floor with polythene or building paper to reduce evaporation of the water in it. Concrete surfaces dust through wear of the neat cement which rises to the surface during finishing. Where high standards of hygiene are necessary the treatment of the concrete surface with a hardener is desirable and one based on sodium silicate is recommended. Joints in floors should be wider than normal to facilitate complete filling with a suitable mastic to discourage infestation.

Walls

Store walls are commonly made of asbestos-cement, galvanised steel or aluminium. Asbestos-cement sheets are somewhat brittle and susceptible to impact damage, which can occur during hailstorms and by rough handling during transportation and erection. In warm regions much supporting timber is poorly seasoned and its high drying shrinkage can both create and enhance small flaws on sheets fixed to it. Rain may then pass through what otherwise would be a water-resistant covering. It is most important, therefore, to ensure that sheets are not fixed too tightly to supports. Asbestos-cement is highly resistant to atmospheric pollution, but in warm, wet regions mould growth is rapid and sheets darken and absorb heat.



Sudan. *Sun-shading by canopies*

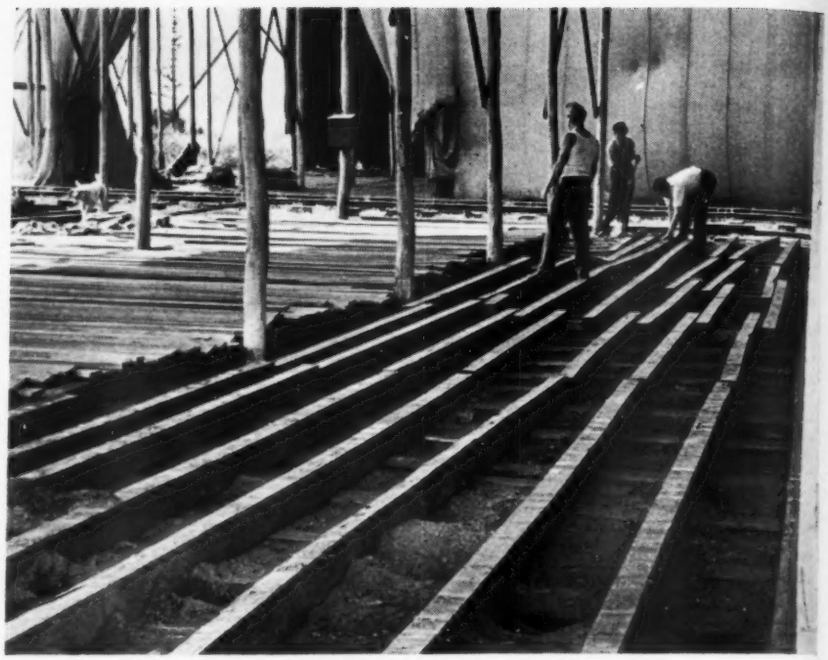
The resistance of galvanised steel to corrosion increases as the thickness of the zinc coating increases. In the tropics corrosion is slow except near the coast, for atmospheric pollution is elsewhere generally slight. Close to surf beaches, however, corrosion can be very rapid and there it is better to use special sheets which have had protective coatings—usually of bitumen-asbestos—applied to them during manufacture. When galvanised steel sheets are cut—for example, to take bolts—the cut edges so exposed should be protected by a coating of bituminous paint.

Aluminium is a light and strong metal. Exposure tests in the tropics have shown that it offers considerable resistance to corrosion, even near the coast, if the correct alloy is used. Type NS-3 (manganese-aluminium alloy) of B.S.1470: 1955 is suitable and is used for most corrugated roofing sheets. Contact under damp conditions with other materials, however, can lead to severe corrosion and should be avoided. Copper and lead are particularly detrimental; so, too, are damp concrete, lime and some types of wood. Fixing accessories in aluminium to B.S.2465: 1954 or galvanised steel to B.S.1494: 1951 should be used. Copper accessories must always be avoided.

Clay bricks and blocks, if properly burnt, and natural stone are very durable in warm climates; their thermal and moisture movements are small and they are not subjected to frost attack. Deterioration is usually associated with the presence of soluble salts formed during manufacture or derived from rising ground water. Even then the usual effect is only one of efflorescence.

Reinforced concrete walls of good quality and well cured are as durable in the tropics as in temperate regions. Reinforcement must, of course, be well covered or rusting and spalling will occur.

Natural soil is used for building in the tropics, but is readily eroded by rain. It has, too, a high moisture movement and drying shrinkage, which promotes cracking and disintegration. Its properties and behaviour can be improved by admixture with Portland cement. Stabilised soil, as it is then called, is similar in properties to a weak concrete. For walls it is used mainly in block form. These need protection from damage by splash-back from the ground and from rain at corners and gable ends. It is advisable to build the lowest two courses in more durable material—*e.g.* concrete block—or to protect the wall at the bottom by a concrete plinth or rendering. Concrete block could, with advantage, be used for the corners and gables could be protected by a rendering.



Insect attack could be heavy in this warehouse. The timber 'flag' floor allows accumulation of spillage which encourages infestation

Mortars and plasters

A good mortar is one that is sufficiently plastic and water-retentive during application to permit a close bond. Mortars of volume composition 1 : 1 : 6 and 1 : 2 : 9 cement:lime: sand fulfil these requirements. Very similar mortars are produced when mortar plasticisers are added to cement : sand mixes of volume proportions 1 : 6 and 1 : 8. Similar cement : lime : sand mixes are recommended for renderings. Dense mixes —*e.g.* 1 : 3 cement : sand—are unnecessary and often detrimental.

Colourless waterproofers can improve the rain resistance of sound, crack-free walls by lining the surface pores with a water-repellent film. Treated surfaces remain permeable to water vapour. This is an advantage, for moisture which may have found its way already behind the treated surface can later evaporate. Colourless waterproofers do not make a wall impervious to water under pressure.

The degree of hygiene needed in a store demands that internal plastering should be as smooth and as crack-free as possible.

Roofs

The pitched roofs of stores are usually covered with sheets of asbestos-cement, galvanised steel or aluminium. Flat roofs to stores are generally of concrete and the main problem is to prevent the deterioration of the bituminous covering. This is susceptible to damage by underlying roof movement, to blistering when applied to screeds which contain free moisture, to standing puddles and to sunlight and heat.

The effect of tropical sunlight and heat is severe, but can be reduced by certain protective treatments. These include reflective or white paint treatments, mineral granules embedded or loosely laid over the bitumen, metallic foil and tile or slab coverings. The difficulty of adequately waterproofing flat concrete roofs has led to the use of superimposed pitched roofs of asbestos-cement, galvanised steel and aluminium.

A fuller account of storage buildings for the tropics, entitled 'Buildings for the Storage of Crops in Warm Climates', has been published recently by H.M.S.O. as Tropical Building Studies, No. 2.

The Pruning of Coffee

A. R. HAARER, F.L.S.*

The author here describes the horticultural, the single-stem, the multiple-stem and the improved Agobiada systems of pruning coffee.

THE practice of coffee pruning probably began in the late 18th century in the Dutch and French colonies and was later adopted by the British. For a long while the system used followed the age-old practice of horticulture.

The general rules were to confine the tree to a reasonable height, *i.e.* between 5 and 6 ft., to grow it with a single stem in the form of a bush, to eliminate all suckers as soon as they appeared, to cut away branches that touched the ground, to ease away growths near the centre of the tree to allow air to penetrate, to prune the secondaries on the herring-bone principle (see Fig. 2), and to cut away all crossing or broken branches and dead wood.

The idea was to give every branch its own share of air and light and to encourage successive healthy secondary shoots on each primary sufficiently near to the main stem to take the place of the primary in case of need for renewal purposes.

Other early methods

These rules were believed in and followed throughout the years until the early 20th century, with two exceptions:

Brazil from the beginning treated coffee more as an agricultural crop. Seeds were sown in the field up to 12 at each spacing, instead of planting nursery plants, and those that germinated were somewhat casually thinned to three or four plants growing to maturity at each spacing, looking somewhat like a multiple-stemmed coffee tree. The main stems were allowed to grow as high as could be reached by standing on a step ladder and very little pruning was attempted except to cut away dead wood and

Fig. 1. Tanganyika. Coffea arabica *var.* bourbon—*an example of single-stem pruning with capping. Note the strength of the lower primaries after capping*

broken branches and to eliminate the suckers.

This practice is still followed in many places in Brazil, but the system is not liked by modern planters because the plants at each spacing are naturally in competition with each other and suffer during drought.

The second exception occurred in Central America, where the Agobiada and candelabra systems have been in use in some areas, about which more will be said later.

Improved single-stem pruning

When the leaf rust disease appeared and pests began to damage coffee severe die-back occurred because the coffee tree is not really amenable to single-stem pruning. The nature of all the economic species of coffee is to grow into tall trees or sprawling growths and to sacrifice their lower branches. The dead wood of Arabian coffee is held in place for a considerable time on the tree, but that of the *robusta* coffee is shed. Pruning did not affect *robusta* coffee in the beginning, although the Dutch, when they first began to grow *robusta* in Java, began to prune it according to the single-stem method.

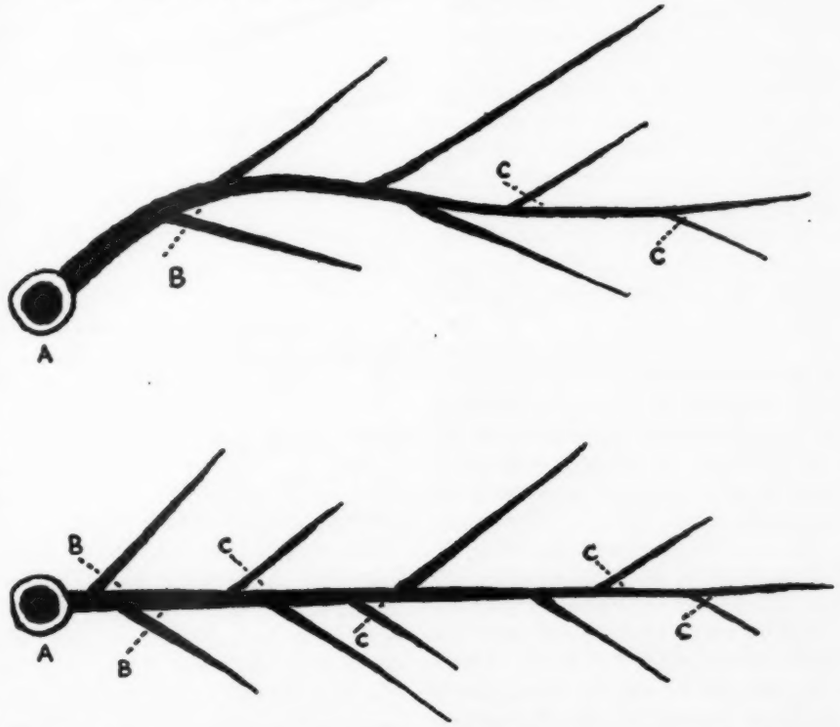


Fig. 2. Orthodox method of pruning primaries on single-stem coffee. C—Surplus secondaries to be pruned away

* Author of *Modern Coffee Production*. Leonard Hill (Books) Ltd. Second edition. 1962. 56*s*. net.

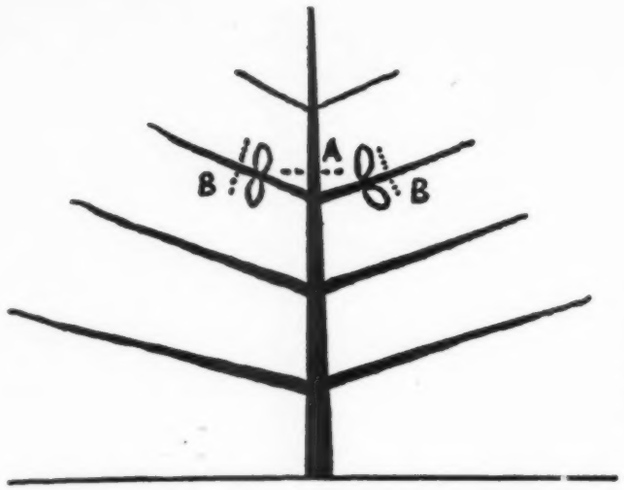


Fig. 3. Capping a young tree. A—The leader shoot is decapitated at knee height. B—The top pair of laterals are pruned back to the basal pair of leaves

not, as the case may be, and permitted to assume a multiple-stem growth.

In the old days the trees were brutally treated—badly pruned if at all—but, despite such treatment, the crops borne by a single bush were surprisingly heavy. Nowadays much greater care is given to the careful pruning of trees by using sharp and proper instruments.

Growers in Kenya and Tanganyika now practice an improved Agobiada system, since the original tip that has been bent over is pruned off when its task has been accomplished; some of the middle primaries on the original main stem are pruned away to make single-stem pruning is shown in Figs. 3 and 4.

Single stem with capping

Efforts were made in Kenya and Tanganyika in the 1920s to improve the method of single-stem pruning by a system known as 'capping'. At knee height, waist high and breast high the leader shoot was pinched out to hinder the flow of sap and to strengthen the lower primaries by halting growth as they were produced.

This was effective (see Fig. 1), but there were several objections: (1) The weight of the two top primaries when they grew longer tended to split the main stem where it had been stopped. So it was found necessary to cut back these to the bud on the first node, thus halting the growth of these top branches, until the cut on the main stem had healed and was strong enough to bear the weight of their growth. (2) This method of stopping the main stem delayed cropping. (3) It did not stop the middle branches dying back in droughty periods, when rust attack was bad, or the trees bore too heavy a crop in an environment that was not quite ideal.

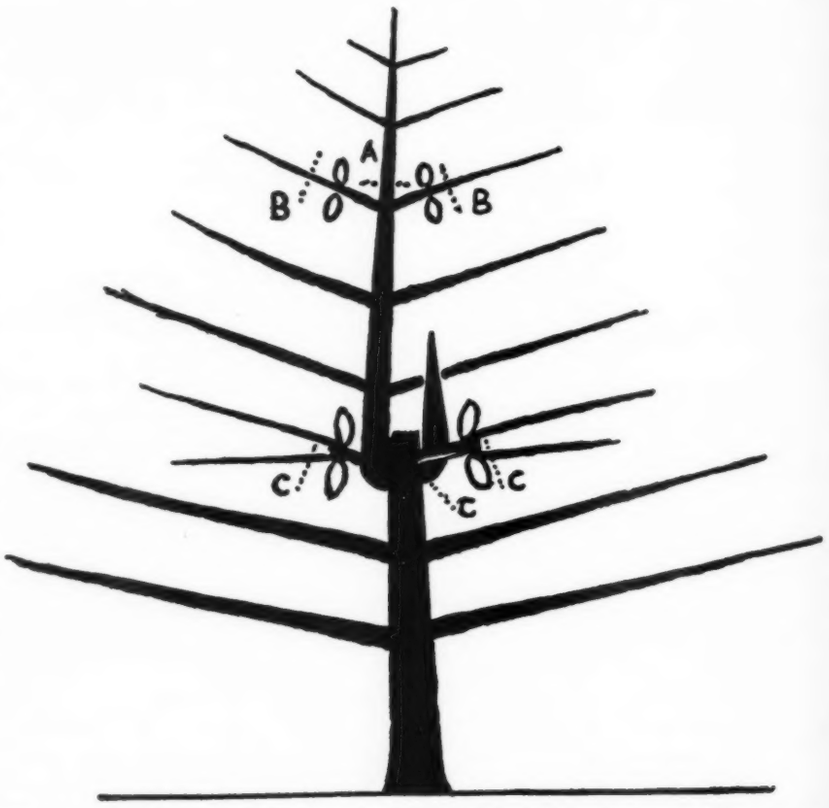


Fig. 4. Capping. A—Second capping at waist high. B—Top pair of laterals cut back. C—Surplus growth pruned away at point of first capping

Correct capping

It should be explained that a sucker, or upright growth of coffee, will not take the place of a branch and that a branch will not, as far as it has been proved, ever produce an upright. When the primaries die back to the main stem this is a serious matter, for these branches cannot be replaced except by a very difficult and quite uneconomic method of grafting. Hence exhausted trees tended to assume the shape of umbrellas with only their top growths alive and in bearing.

The correct method of capping for

Multiple-stem system

The Agobiada system was first used, and still is used, by growers in Mexico—at a proper height the main stem is bent over in a curve until the tip nears the ground and it is pegged or tied down in such a position until the curved stem becomes set. Several sucker growths emerge from the arched portion and are thinned out or room for the new growths and only three uprights are usually permitted to grow. As they grow upwards and fruit the new uprights bend away from each other, assisted by the pickers pulling the tops downwards (see Figs. 6 and 7).

The candelabra system

In Ecuador and some other regions in Central America a candelabra system was once practised. It merely means topping the leader shoot to

obtain two and topping the subsequent two to obtain four, and so on. When one starts one never knows when to stop; there is the danger that the two halves of the tree will split away from each other, and, in any event, the grower loses his system as he chooses renewal suckers from the base and the system develops into a crude form of multiple-stem pruning.

True multiple-stem system

The true multiple-stem pruning is to cap or stop the leader when it is still quite young at about 1 ft. high and to stop one of the subsequent shoots to obtain, in all, three leader shoots growing upright if a third does not spring from the stump (see Fig. 5).

The subsequent pruning of all multiple-stem growth is simple. As the stems grow up, the lower primaries bear and weaken, so they are cut clean away, leaving just the healthy younger primaries nearer the tips of the uprights.

With this system the coffee grower can have more cut away if he desires to reduce the subsequent crop, and he simply hands out measured sticks to his pruners. A pruner places his stick along a main stem, measuring from its tip, and prunes clean away any primaries which he finds growing beyond the length of the stick—a simple operation.

Trained men are needed, however, when the time comes to start renewing the uprights. These are sawn away at the base in turn, leaving two growing permanently. The leader is cut back, if possible, to a young sucker sprouting near the base, as they have the habit of doing as the leaders bend farther and farther away from each other, owing to their length and weight. Some growers have four leaders in the beginning, reducing to three when renewal begins.

Following the saw cut, which must start and be carefully done, the rough surface of the cut should be cleaned up with a sharp knife; in fact, all pruning implements must be kept keen and sharp. At the time the saw men go round the ganger of the pruning gang ahead has broken the tip of the leader which is to be sacrificed.

It is usual at the same time to see to any reduction in shade and to lop or prune the shade trees just as carefully as the coffee, leaving no 'hat pegs', *i.e.* jutting pieces without buds, and no splits or tears.

Pruning of robusta coffee

The system for robusta depends on the cultivar or variety. *Coffea canephora* var. *canephora* has a robust, upright growth which, if left to mature, would form into quite a stout tree. This variety is best pruned to the Agobiada or true multiple-stem system as previously described.

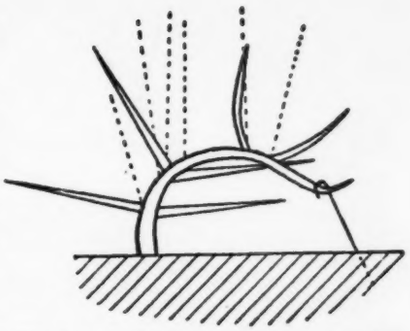


Fig. 6. Agobiada multiple-stem pruning. The young plant has had the main stem bent over and tied or pegged down. The dotted lines show from where leader shoots may be expected to grow

With the more sprawling *Coffea canephora* var. *nganda* (somewhat similar, it is thought, to Quillou coffee) the best method to use is the improved Agobiada system.

Improved Agobiada system

The first upright and subsequent sucker growths, as they grow tall enough, are bent in arches away from each other, north, south, east and west, and their tips tied down. Subsequently more suckers will grow from each arched stem and as they grow upwards and bear fruit their weight, together with the pulling of the pickers, makes them bend outwards. Then a third and fourth generation of suckers grow in turn like a fountain springing from the centre of the tree, and in this manner new growth is always appearing until the tree becomes a huge dome rather like a large rhododendron bush (see Fig. 8).

Exhausted primaries die and are shed by the tree and further pruning consists merely of cutting away split and broken branches. It is this method that is so successfully used by the African farmers in Uganda and in Bukoba district of Tanganyika Territory (see Fig. 8).

Comparative trials

An experiment carried out for more than 18 years at the Coffee Research Station at Lyamungu in Tanganyika to compare the yields of single-stem versus multiple-stem pruned coffee showed very little difference in yield

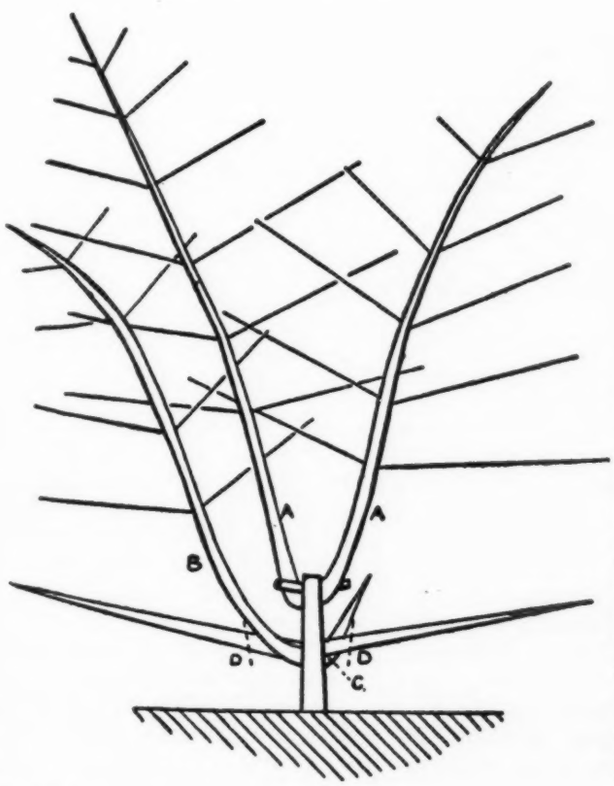


Fig. 5. Multiple stem or 'long top' pruning. A—Two leader shoots. B—A third leader encouraged by pruning away the lower primaries at D, or by recapping the new leaders A. The multiple stems are beginning to lean away from one another and the lower primaries, becoming exhausted, have already been pruned away. No secondaries are allowed to grow

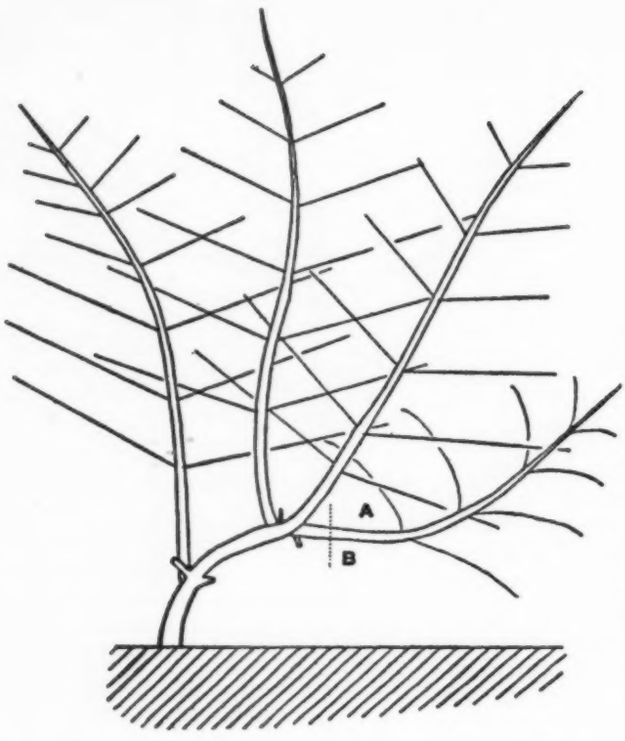


Fig. 7. Agobiada multiple-stem pruning at an advanced age. Three of the strongest shoots have formed new leaders that are beginning to bend away from one another. This pruning is similar to the 'long top' method. The original leader shoot A can either be allowed to remain or be pruned away

from the sixth year onwards, sometimes one system proving heavier and some years the other, although during the first five years the yields were very much in favour of a multiple system of pruning. It is a fact, however, that no mention had been made of capping, and had capping been done the single-stemmed trees might have far outweighed the other system in total yield over 10 or 15 years.

One point is important. Where the environment is correct in every way, as it is at 5,000 ft. upwards on the south-eastern slopes of Kilimanjaro Mountain, coffee trees bear on their older wood, on the thicker branches and even on their main stems.

Discussion

It would seem sacrificial to train trees to the multiple-stem system in such a region and thus try to force the trees to bear on the young wood, as they do where the environment is not so satisfactory. Indeed, in areas of less moisture and hotter temperatures, Arabian coffee invariably bears on its young wood, hence the value in by far the greater part of the coffee-producing world of the newer multiple-stem system of pruning coffee.

There are, however, growers who still firmly believe in the single stem and capping and, indeed, they are right in those special regions where Arabian coffee bears on the older wood. Grown and cared for properly, Arabian coffee trees increase in value and yield as they grow older and the limit of age and yield is not yet known. Wherever statements have been made to the contrary the senility may have been due to avoidable causes.

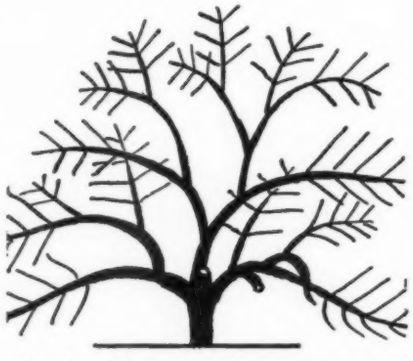


Fig. 8. Diagrammatic arrangement of branching habit of Coffea canephora *var.* nganda

If coffee is to be pruned on the single-stem system in the best environments where it tends to grow on old wood, every possible means must be used to strengthen the frame of the tree and the lower and middle branches before the tree is stopped at its permanent height of from 5-6 ft. and before it begins to bear.

Selected seed should be used and the young plants planted out properly in holes not less than 2 ft. wide x 1 ft. 6 in. deep. Capping must be practised. It has been proved at Lyamungu that the best time to prune is immediately after harvest and before another month has passed.

Little pruning best

It has been shown both in India and East Africa by carefully repeated trials that as little pruning as possible is best, *i.e.* merely to cut away dead and diseased wood and any very awkward growths. The coffee tree is apt to respond like tea to heavy pruning, and the more the knife is used the more growth and leafage is obtained at the expense of fruit. In fact, the policy of no pruning has given the best results in India, though this would not be sound practice in the long run.

Mills in Gobi Desert

Hungarian engineers have set up two 20-ton, Hungarian-made, pneumatic flour mills in the northern corner of the Gobi Desert, at a small settlement called Har-Horin, 300 miles from Ulan-Bator, Mongolia.

The area is populated mainly by nomadic shepherds. Two Hungarian millers have stayed on to teach the shepherds how to operate the mills, which are the first ever installed in a region in which flour was virtually unknown.

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*The Phytotron**

Artificial Climates to Aid Food Production

DUPLICATION of almost every known climate—with at least 140 different conditions at the same time—will be possible soon within the walls of a special building now nearing completion on the lower slopes of Black Mountain in Canberra, the national capital of Australia.

The Pasadena phytotron

The latest phytotron, which will be in operation next year, will differ in design and scope from those already established in the U.S.A., Belgium, Holland, South Africa, France, Sweden and Russia, although it will embody the basic principles of the original controlled plant house which was designed and built at Pasadena, California, in 1949.

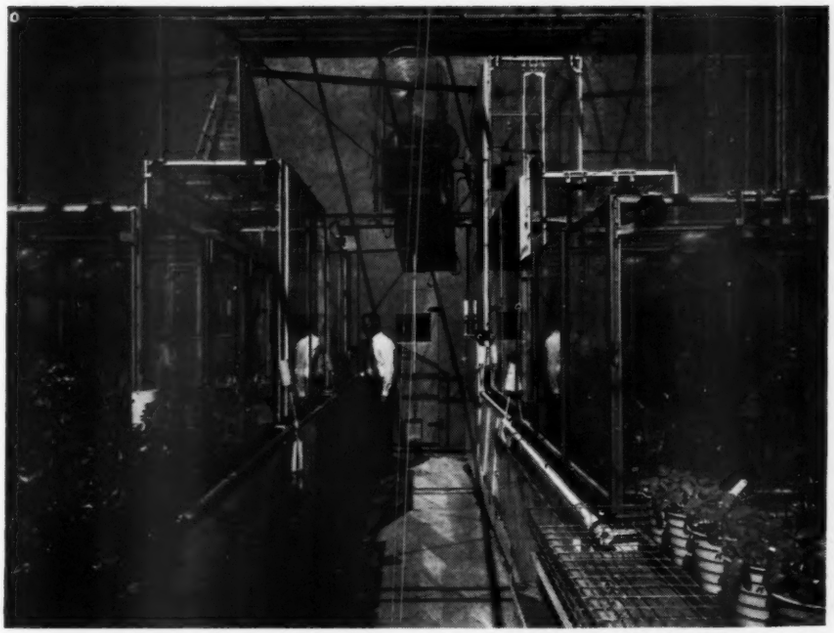
The original phytotron made it possible to expose plants to more than 500 different and precisely known climatic conditions. Plants could be subjected at will to winter cold or summer heat, to rain or sunshine, to wind or fog or to variable day and night conditions. The vagaries of the weather, the snap frost or sudden heat wave that could ruin months of experimentation in field plots, could be eliminated, as required, by working in a controlled climate.

Some surprising results

Perhaps one of the most striking, and a quite unsuspected, result, was the effect of night temperatures on the yield of tomato crops. The phytotron revealed that different varieties of tomatoes reacted differently to varying night temperatures. Indeed, the yield of one popular Californian variety trebled when night temperatures in a phytotron test were reduced from 85°F to 50°F.

In order to suit warm night temperature conditions, a new tomato variety was produced by cross-breeding with an otherwise worthless Philippine strain that had reacted favourably to a phytotron screening test to determine its suitability for high night temperatures.

As the result of such investigations the huge tomato-growing industry of U.S.A. underwent many changes. It became possible to recommend with greater accuracy the correct planting times and the most suitable districts for existing varieties and to regulate fertilising programmes according to weather conditions. New strains evolved in the phytotron also made it possible to extend commercial tomato growing into areas that had previously been unsuitable because of excessively high night temperatures.



Photos: Australian News and Inf. Bureau

The prototype phytotron in which 'climate' cabinets were tested by scientists of the Commonwealth Scientific and Industrial Research Organisation before installation in the new phytotron building

The need in Australia

Only one-tenth of the 3 million sq. miles of Australia, *i.e.* the coastal strip surrounding the vast arid inland area, receives sufficient moisture to be suited for agriculture, and only one-quarter of the whole continent can support plant growth for even five months of the year.

Of this area, only one-third is suitable for improvement, and even the fertile areas are subject to annual periods of drought—during summer in the south and in winter in the north—and these periods are unpredictable and vary greatly from year to year.

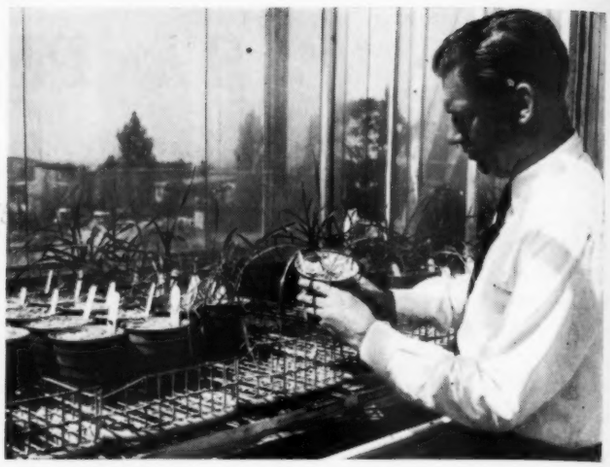
Unfortunately, few of the indigenous or native plants that have evolved in this peculiarly difficult environment are useful. It is extraordinary that practically every plant that is of economic importance in Australian agriculture today has been introduced, often by chance, from its original home in other countries.

A great deal of ingenuity and hard work by farmers and scientists has resulted in the successful adaptation of many of these imported plants to Australian conditions. The breeding of a rust-resistant wheat by William Farrer, for instance, made it possible for Australia to become one of the first four wheat-exporting countries of the world.

Influence of research

The economic progress of the agricultural industries of Australia have hitherto been largely due to the success of scientists in defining and ameliorating the many mineral deficiencies in the soils. The main hope now of

* Phytotron: (Gr.) Phyto: plant; -tron: measure.



Seed germination tests in an artificially lit phytotron cabinet. Right: *A botanist examines the growth of a plant under test in the prototype phytotron*

further increasing agricultural production lies in introducing crop and pasture plants that can exploit these difficult climatic conditions and produce good yields.

Indeed, the scope of the planned introduction of new varieties of crop and pasture plants from countries overseas is almost unlimited, particularly for the vast tropical areas of the north still awaiting development. It is for this reason that an efficient system of testing these introductions is required.

Under the controlled conditions in the phytotron it should be possible to save years of research work in laboratory and field, where success or failure could easily be the result of a chance change in the climate over which there was no possible control.

The latest phytotron

The Australian phytotron will incorporate 140 specially designed cabinets in which the temperature, light intensity and moisture content will be regulated. In some of them the use of artificial light and automatic shutters will control the periods of 'daytime' and 'night'. This will provide an almost infinitely variable system of climatic changes in a single building.

Prototype glass cabinets and mechanical equipment to control climatic factors have been under test by the C.S.I.R.O. at Black Mountain since the Government decided to finance the phytotron project in 1958.

This use of individually controlled cabinets is the main difference between the Australian and the earlier types of phytotrons in other countries. Earlier types generally followed the design of Prof. Went's original 'climatic factory' at Pasadena, which consisted of a small number of rooms and required the movement of plants from one room to another to obtain an appreciable number of different climatic treatments.

The Australian cabinet system, with banks of eight cabinets in 15 separate units, will do away with this movement of plants under test, so reducing labour costs, the risk of damage to plants and possible loss of control or error in 'condition setting'.

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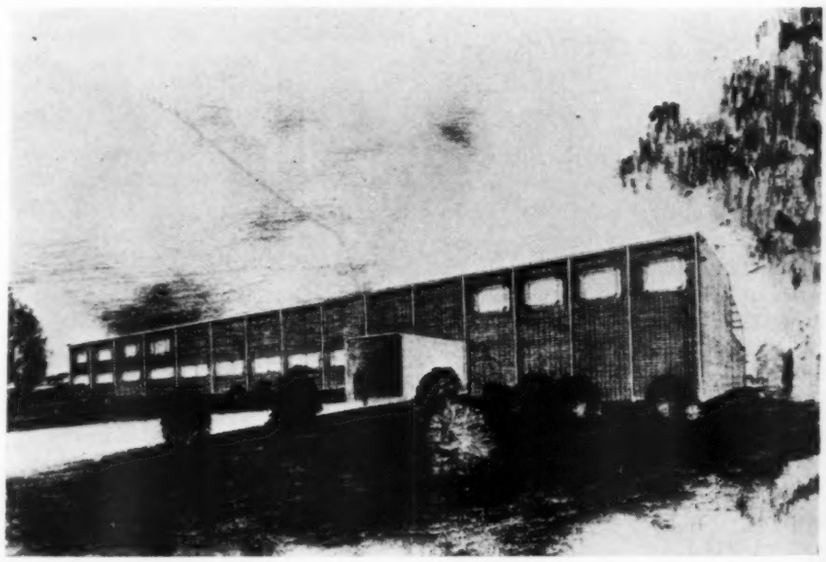
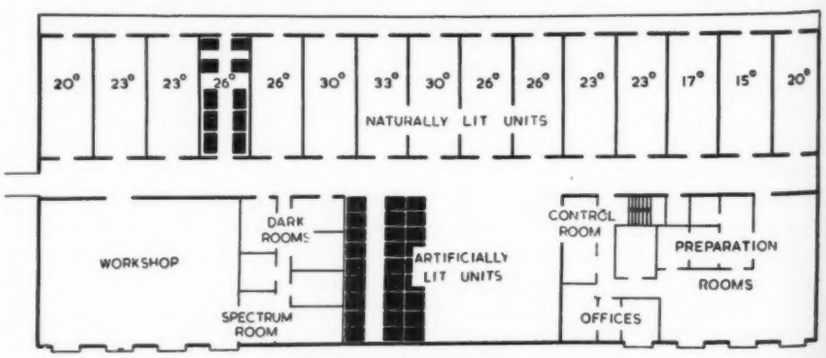


An artist's impression of the new phytotron, now under construction



Plan of the new phytotron

World News

India

Fast-growing Trees

Present forest resources in India do not meet the requirements of the present population of 420 million, let alone the estimated population for 1975 of 600 million. India is famous for the production of valuable, slow-growing timbers; however, present conditions demand a vast increase in the supply of wood, which can only be met by planting fast-growing species. It is proposed to select about 1% of India's forest area, in the most productive parts of the country, and to plant 150,000 acres per year over the next 10 years with trees which will mature within 15 years.

This development, coupled with intensive management aimed at raising the forest yield per acre, should double the present production of industrial wood. Other recommendations include the development of the Himalayan coniferous forests, expanded use of low-grade timber, and the use of building board instead of solid timber.

Kenya

High Rice Yields

Some extremely high-yielding wet rice crops are being produced in the M.W.E.A. Irrigation Scheme in Kenya. Average yields so far recorded are 24.5 bags per acre against a world average of approximately seven bags per acre. Individual farmers taking part in the scheme are reported obtaining yields of over 40 bags per acre. The whole scheme is tenant farmed and the area is divided into 1-acre plots or paddies. Each tenant is allotted 4 acres and his average earnings are around £125 per annum. Cultivation is carried out by rotavators on a contract basis by the Department of Agriculture at a charge of 25*s.* an acre.

Tanganyika

Training Field Assistants in U.S.A.

About 98% of Tanganyika's population earn their living from the land, for agriculture is the mainstay of the territory's economy. Nine men have been selected to go to U.S.A. to study agricultural extension work through the generosity of the International Co-operation Administration.

Sarawak

Rubber Seedling Nursery

In less than a year the Sarawak Agricultural Department has established a rubber seedling nursery on waste ground formerly covered with sheet lallang (a tough wild grass).

One hundred and twenty acres of land were cleared by bulldozer, ploughed and cultivated by tractor and converted into a nursery. Apart from final preparation of the seedbeds, the whole operation was carried out mechanically. More than 5 million clonal rubber seeds were imported from Malaya and allowed to germinate. From these has been planted a stand of 3,720,000 clonal stumps which will be issued to approved applicants under the Rubber Planting Scheme, and which it is estimated will be sufficient for 14,850 acres of rubber plantation.

Over the next two years it is hoped that the Department will be able to increase the cleared acreage to a total of about 250 acres.

This land will be contour-lined and 180 seedlings will be left on each acre. These will be budded with Tjir 1 clonal budwood, thus converting the area into a block planting of high-yielding budded rubber. Within 10 years sufficient seed capacity will be planted there to supply all the future needs of Sarawak and will save importing seeds from Malaya.

Russia

Plant Growth Stimulator

A new growth stimulator, 'N.R.V.', produced from waste oil from the Baku refineries in the U.S.S.R., accelerates the metabolism of plants, so it is reported. It is claimed that the application of ¾ oz. per acre will increase the yield of cotton by 20%, of tomatoes by 30% and of egg plants (aubergines) by 40%.

It can be used either as a top dressing or as a seed dressing. A weak spray solution (0.005%) gives additional yield of 48 cwt. per acre for cucumber crops. Graded maize seeds soaked in a similar solution increase their yield by over 20%, it is claimed.

In 1960 the Academy distributed more than 50 tons of 'N.R.V.' in Azerbaijan.

(*Concluded from previous page*)

Isolation from infections

Extraordinary precautions are to be taken to prevent the introduction of plant pests and diseases. All air entering controlled areas will be electrostatically filtered and the inside atmosphere of the building is to be maintained at a slightly greater pressure than outside to reduce the risk of contaminated air entering the building. Employees and visitors to the phytotron will be required to change into specially sterilised clothing before entering controlled sections.

Each enclosure and its bank of cabinets will be isolated from the others with a separate double access and a separate air circulation system. If, in spite of these precautions, infection by disease or pest should occur, control by fumigation can be confined to the unit concerned and will not affect other experiments.

Automation in control

Australia's phytotron will be unusual not only for its ability to cope with a much fuller range of climatic conditions than was possible with the earlier types, but also because of the high degree of automation in its management.

It will theoretically be possible for the phytotron to continue operating for long periods without attention. Automatic devices will close and open cabinet shutters and turn lights on and off to control 'daylight' and to regulate air temperatures and humidity levels.

A continuous record of all physical data of the numerous experiments will be maintained mechanically and an electronic 'baby sitter' will watch over all the other automatic devices.

Coming Events

Water Treatment. — The second Effluent and Water Treatment Exhibition and Convention will be held in the Seymour Hall, London, from 31 October-3 November. Enquiries to the Exhibition Press Officer, 2 Broad Street Place, London, E.C.2.

Weeds.—The Annual Weed Conference is to be held by the Washington State Weed Association on 6-7 November. Further information from the Washington State Weed Association, Chinook Motel and Tower, Yakima, Washington, U.S.A.

Insecticides and Fungicides.—A conference on insecticides and fungicides will be held in Brighton from 7-10 November. The conference is sponsored by the Association of British Manufacturers of Agricultural Chemicals. Further details from A.B.M.A.C., 86 Strand, London, W.C.2.

Fertilisers.—A lecture entitled 'On Getting Through to the Farmer', to be given by Kevin FitzGerald, has been arranged by the Fertiliser Society to take place in the Lecture Hall of the Geological Society, Burlington House, Piccadilly, London, W.1, on 23 November. Another lecture entitled 'Reactions of Phosphate in Soils' by E. O. Huffman will be given at the same venue on 22 February, 1962. A third lecture entitled 'Soil and Fertiliser Potassium in Crop Nutrition' will be given by R. G. Warren, P. W. Arnold and A. E. Johnston on 29 March. Those interested should write to the Secretary, The Fertiliser Society, 44 Russell Square, London, W.C.1.

Mechanical Handling.—An exhibition of aerial ropeways, earth-moving equipment, static and mobile cranes, trucks, conveyors, elevators, grain, powder and chemical handling plant and bottling plant will take place at Earls Court from 8-18 May, 1962. Further details may be obtained from H. A. Collman, Exhibition Manager, Dorset House, Stamford Street, London, S.E.1.

Water Purification.—The first European Symposium on Fresh Water from the Sea has been arranged by the European Federation of Chemical Engineering to take place in Athens from 31 May-3 June, 1962. Evaporation processes, electro-dialytic processes and desalting of brackish water will be considered by the presentation of principal lectures and short papers followed by discussions. Offer of papers to the Secretariat, European Symposium on Fresh Water from the Sea, Union des Chimistes Hellenes, P.O. B. 199, Omonoia, Athens, Greece.

Grassland.—The National Grassland Demonstration will take place on 5-6 June, 1962, at Harrogate, Yorkshire, England. There will be working demonstrations of silage-making and hay-making. In addition to this, there will be an advisory exhibit and an exhibition of static machinery. Further information may be obtained from Shell Chemical Co., 170 Piccadilly, London, W.1.

Agricultural Exhibitions

Canada.—The Royal Agricultural Winter Fair will be held at Toronto from 10-18 November. Enquiries to J. R. Johnston, Royal Coliseum, Exhibition Park, Toronto, 2B.

England.—The Royal Smithfield Show and Agricultural Exhibition will be held at Earls Court, London, from 4-8 December, 1961. Further details may be obtained from the Smithfield Show Joint Committee, S.M.N.T., Forbes House, Halkin Street, London, S.W.1.

Holland.—A Farm Machinery Exhibition will be held in Amsterdam from 22-27 January, 1962. Particulars from R.A.I. Gebouw N.W. Europaplain 8, Amsterdam.

Belgium.—An International Agricultural Machinery and Equipment Exhibition is to be held in Brussels from 11-18 February, 1962. Enquiries to Société de Mecanique et d'Industrie Agricoles, 29 rue de Spa, Bruxelles 4.

Libya.—An International Industrial, Commercial and Agricultural Fair is to be held in Tripoli from 20 February-20 March, 1962. Further details may be obtained from Dr. Ali Jazairy, Tripoli International Fair, Giaddat O. Muktar Tripoli, P.O. Box 891, Tripoli.

Verona.—The 64th International Agricultural and Animal Farming Fair will be held from 11-19 March, 1962. Enquiries to Fiera di Verona, Piazza Bra, Verona.

France. — The 33rd Agricultural Machine Exhibition will take place in Paris from 6-11 March, 1962, at the Exhibition Park, Porte de Versailles. Further information from the Salon International de la Machine Agricole, 95 rue Saint-Lazare, Paris 9e, France.

Italy.—The International Packaging Exhibition is to be held in Milan from 1-8 June, 1962. Further information from Overseas Exhibition Services, 11 Manchester Square, London, W.1.

Yugoslavia.—The 29th International Agricultural Fair will be held at Novi Sad from 1-11 June, 1962. Enquiries to Novosadski Sajam, Hajduk Veljokova 11, Novi Sad, Yugoslavia.

Oil Palms for North Borneo

The Colonial Development Corporation has announced further developments at Mostyn Estate in North Borneo where oil palms were first planted on a commercial scale in 1957.

The scheme now comprises some 5,000 acres to be operated on an estate scale, coupled with 1,400 acres on which 100 families are to be settled as smallholders. In due course, a factory of sufficient size to process the palm fruits, produced on the company estate and by the smallholders, is to be erected.

This interesting new system of estate-smallholder partnership will be watched with interest, as it would appear to be of obvious benefit to all concerned.

Water for Tea

J. S. STOWER,* M.C.

Now that artificial rain systems are available, it is possible to use water far more effectively and economically than by the method of furrow or open-ditch irrigation.

'DOES irrigation pay?' is a question that many tea growers are asking themselves following the disastrous droughts which have been experienced in certain areas in recent years. The financial loss in a single year's cropping due to drought can represent the total capital outlay for establishing an overhead irrigation system where the conditions are favourable for its installation.

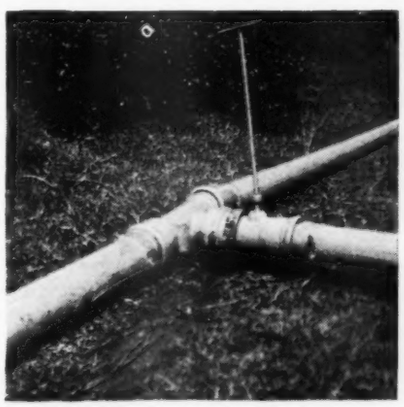
The first essential is to have or to find an adequate source of water within reasonable reach of all parts of the estate. The most satisfactory and inexpensive source is a river or stream, or else a reservoir which can easily be replenished from a river or stream. If neither is available, consideration should be given to the construction of wells or the sinking of boreholes at convenient points, whichever is recommended by the irrigation specialist who plans the scheme. It takes nearly 23,000 gal. of water to provide the equivalent of an inch of rain on an acre of ground, so it will readily be appreciated that irrigation requires a vast and continuous supply of water.

Equipment required

It is advisable to divide the estate into 'irrigation areas', each of a size capable of being dealt with by a portable set of equipment comprising a 50-h.p. diesel-driven pumping unit, about 2,000-3,000 ft. of 6-in. light alloy aluminium portable mains to be laid out roughly through the centre of each area, and 820 ft. of 5-in. light alloy aluminium sprinkler line to form laterals at right angles on either side of the main. Along these laterals would be spaced rotary-type sprinklers mounted on 4-ft. high risers, and the equipment should be so arranged that, by successive moves, the equivalent of 2 in. of rain can be applied over an area of 100 acres in two weeks.

The equipment must, of course, be capable of quick and easy moving. The pumping unit should be mounted on a trailer for towing by tractor and equipped with an electric starter, priming pump and wander lights for night operations. The portable aluminium mains should be of sufficient strength to protect them against rough handling in the field and yet light enough to be carried easily in 20-ft. or 30-ft. lengths. The connecting couplings should be so constructed that the man handling them need not bend down to connect them together. The type recommended is one which protects the ends of the pipes because these are susceptible to dents resulting in leaky joints.

Portable diesel-driven pump unit drawing water from the river and delivering it into a 6-in. main



Tee-junction showing the control valve for diverting water from the 6-in. main into the 5-in. sprinkler line

An aluminium quick-release coupling without latches or clamps. It becomes water-tight under pressure and the lateral can follow the undulations of the ground

Types of Sprinklers

Rain-gun sprinklers are not suitable for tea, as the weight of water and droplet size are too heavy for this crop. The powerful jet of water may be seriously disturbed by gusts of wind, resulting in uneven watering, and the high trajectory necessary for covering a large area means that the shade trees will receive most of the water.

On the other hand, small rotary sprinklers are also not to be recommended for tea, although for many plantation crops they might be quite suitable. The limited coverage of these small sprinklers involves frequent moving of the line and adds to the time lost through such moves because the smaller sprinklers require careful handling as they are liable to be broken off.

The ideal is the medium-size sprinkler—one which can be spaced at intervals of approximately 150 ft. to produce a watered strip 200 ft. wide. Allowing for the necessary overlap, the line can be moved to the next position 100 ft. laterally to the next junction

* Managing Director, British Overhead Irrigation Ltd.

Two Africans, each carrying two 6-in. light alloy aluminium pipes 20 ft. long

along the main to obtain uniform watering.

A suitable sprinkler unit for applying rain at the rate of ½-¾ in. per hour will need to be left in each position for three or four hours.

A spare sprinkler line, although adding to the capital outlay, is a justifiable expenditure because it materially speeds up operations and the unit will be capable of covering larger areas within the watering cycle. Moving an 820-ft. sprinkler line may take two men three-quarters of an hour; the spare line eliminates this loss of time, as the water can be turned on in the new area before the move is commenced, so there is no delay at all.

There are other important considerations: water pumped from rivers, streams and boreholes often carries abrasives, such as sand, which will damage the bearings and sprinkler mechanism. Some sprinklers are fitted with special bearings and protective washers to keep out abrasives and these will last longer and give less trouble.

Sprinklers on a 5-in. line operating among the tea bushes

One of the sprinklers mounted on a 4-ft. riser

The approximate price for a set of equipment as described would be about £3,000 or £30 per acre. It could be less or more, depending on the position of the source of water in relation to the area to be watered, the layout of the plantation and the nature of the country.

Letter to the Editor

Sir,—Mr. J. C. Hawkins' paper on mechanisation of small farms in underdeveloped countries, published in the August issue of WORLD CROPS, expresses views on the 'two-wheeled tractor' or 'power tiller' which, while pertaining in the lesser developed countries until as recently as four years ago, are certainly not applicable today.

The paper which I have submitted for publication in the November issue of WORLD CROPS, titled 'From Bullock to Tractor—In One Stage or Two?', presents, perhaps, what is the more up-to-date position pertaining in this part of the world. In his paper Mr. Hawkins refers to the adverse cost of the earlier two-wheeled tractors in relation to their power output when compared to the four-wheeled tractor. The position prevailing where the newer 'power tillers' are concerned is contrary. For example, an average retail price in Asia of a 35-h.p. four-wheeled tractor is about £800, which is equivalent to £23 per h.p. The corresponding retail price for a 4½-h.p. power tiller is about £100, the equivalent of £22 per h.p.

He next refers to the higher operational cost of the earlier two-wheeled machine. The following comparative figures of the present-day position, based on an average eight-hour working day, show a welcome change. For example, the four-wheeled 35-h.p. tractor consumes 6 gal. of kerosene while ploughing 3 acres of land, an average of 2 gal. per acre. The power tiller consumes 1.8 gal. of kerosene for the ploughing of equal depth per acre of similar ground.

I am sure my friend, Mr. Hawkins, is too great a scientist to object to my bringing him up to date where mechanisation in the lesser developed countries is concerned, countries through which I am constantly travelling, being also a resident of them!

RAY WIJEWARDENE,
Director.

Landmaster Ltd.,
133 Turret Road,
Colombo 7, Ceylon.

Russians Visit Britain

Three Russian agriculturists—a farm manager, an agricultural engineer and a scientist on a plant breeding station—recently came to Britain for a three-week study tour arranged by the Agricultural Research Council in collaboration with the British Council.

They were Mr. Pronin, the director of a state farm, Mr. Stepanov, who is assistant director of the largest plant breeding station in the Russian Republic, and Mr. Kovalenko, an agricultural engineer from the Ukraine.

Anglo-Soviet exchange

This is part of an Anglo-Soviet agreement providing for the exchange of seven British and seven Soviet agricultural research workers between this year and 1963.

The Russians visited agricultural and horticultural research institutes and farms in Somerset, Warwickshire, Hampshire, Hertfordshire, Bedfordshire, Essex and Kent.

They also paid a four-day visit to the Scottish Horticultural Research Institute at Dundee.

Packaging World Crops

REVIEWED BY D. H. GRIST

This is a necessarily brief review of a few of the exhibits at the International Packaging Exhibition held in London.

Collapsible Cases

A. Latter & Co. Ltd. are suppliers of 'Mussy' wire-bound boxes designed to carry up to 3 cwt. of produce. Six of the 18 standard sizes have been specially designed for horticultural products.

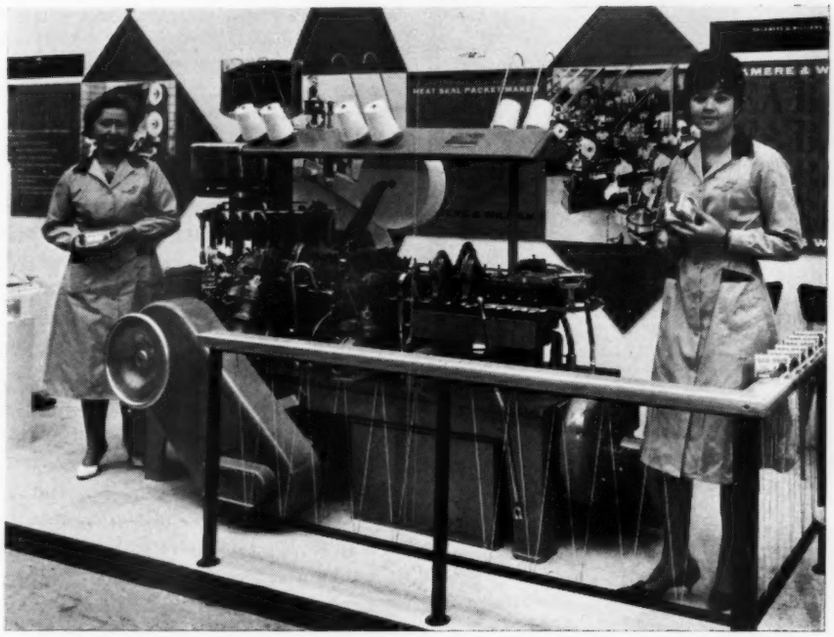
The box consists of slats of relatively thin wood linked together with steel wire strapped to them, no nails being used. Delivered flat, with the two ends already attached, the unassembled boxes can be stacked in a small space. Thus 11,000 boxes, each with a filled capacity of 2.8 cu. ft. each, when unassembled and stacked 17 ft. high, occupy only 450 sq. ft. The collapsed box is light and lends itself to easy assembly by an unskilled operator at the rate of 125 boxes an hour.

The crush resistance of wire-bound boxes also allows high stacking of the filled boxes. It is claimed, too, that this box combines the stability of a wooden case with a weight-carrying capacity greater than that of fibreboard containers; it is economical in cost, since it uses a minimum of wood to maximum effect.

Stencilling and Marking

The 'Kabey' quick-marking system is used for applying identification marks to boxes, crates, drums, bales, sacks etc. The outfit consists of type-holders of various sizes with one to four lines, appropriate composing cradles, letter set, number set, ink pad and roller and other accessories. Distributors in the U.K. are *Paul Plura & Co. Ltd.*

The holders are of light aluminium alloy, curved for straight surface marking or straight for curved marking. A simple spring-lever action picks up the composed types from the cradle and grips them firmly. The type is inked on the ink pad and the surface marked with a simple rocking motion. The resilient rubber types give a full-letter impression even on rough surfaces.



Tea bag-making machine seen on the Canadian stand at the Packaging Exhibition. The loose tea is in the hopper (left) *and the finished bags of tea may be seen* (right)

Tea Bags

'One for the pot' may one day be a thing of the past, for already most Canadians and Americans prefer to make their 'cuppa' with a tea bag which holds about two teaspoons of tea.

The use of such tea bags obviates the need for a tea strainer, eases washing up and prevents drains becoming blocked with spent tea leaves.

A tea-bag-making machine manufactured by *Delamere and Williams Co. Ltd.* is one of three machines which were seen in operation on the Canadian stand at the Exhibition. The model MT 'Rotorex' machine will make, fill and seal gauze tea bags, 2½ in. x 2½ in., automatically at a rate of 130 a minute. The machine is designed to use gauze fed from a roll, but paper can also be used for making paper bags for seeds etc. if so required.

Nylon Packaging

'Ralsin', a tough, transparent packaging film which maintains its stability in boiling water and deep-freeze conditions, was shown by *Whiffen & Sons Ltd.* It has special application for foods which are to be cooked or heated in the pack. It is a polyamide (nylon) material which is chemically inert, absorbs a negligible amount of water and is unaffected by hydrocarbons, oils, fats, greases and other elements normally found in food. As it is non-toxic and contains no additives, it does not affect the flavour of the contents.

Damage in Transit

The 'Patra' drop recorder instrument, produced in the Leatherhead laboratories of the *Printing, Packaging and Allied Trades Research Association*, marks a big step forward in the investigation of journey hazards. This intricate mechanism, placed in a consignment, stores up vital information that tells scientists exactly what happens to a box on a journey. The instrument not only records every drop received, but it can tell the drop

height, the side on which it fell and the hour and date of each impact. If the package is stored, it will say on which side the container stood and for how long.

A new tomato tray introduced by Reed Corrugated Cases Ltd. The trays are faced with white kraft and the tapered construction is an aid to easy stacking

Plastic Bags

Plastic Weldings Ltd. exhibited a range of large plastic bags suitable for a wide variety of liquid products, such as detergents, insecticides, fertilisers, acids and fruit juice concentrates. For the manufacture of these 'Vitherm' packs, polyvinyl chloride (PVC) is used —a plastic with high tensile strength and considerable resistance to pressure. Two layers of this material joined together will ensure freedom from pinholes and porosities.

The container is provided with a tap made of polyethylene and polystyrene. After the bag has been filled this tap is inserted by machine.

The plastic container is enclosed in a solid board outer, resting on a fibreboard tray, and the top lid is sealed on with pressure-sensitive tape. For use the top lid is removed, a die-tongue pulled down so that the tap projects and the container is then ready for pouring.

Lifting Device

Lodematic Ltd. have produced a high-speed, light-weight loader for the automatic handling of sacks and boxes—the Lodematic 'Mark B' 10-ft. lift model.

When loaded the platform lifts and then halts automatically at any pre-set intermediate level; when unloaded it descends. Semi-automatic and manual valve lever controls are also available for batch handling of cartons, cases and similar loads of agricultural produce. A mains electric motor or small petrol engine powers the hydraulic system and up to 224 lb. can be lifted at a time. When telescoped, this two-wheeled unit can be pushed like a truck.

Polythene Sacks

'Diosacks', produced by the *Metal Box Co. Ltd.*, are heavy-gauge polythene sacks suitable for almost any product that is usually packed in jute or paper sacks. They will withstand extremes of temperature from 30° of frost (—20°C) to over 200°F (95°C).

The sacks are supplied with a choice of two tops—completely open or sealed except for an aperture about $5\frac{3}{4}$ in. long left for filling and subsequent sealing; they may be closed by sewing, tying or by bar or band-heat sealing.

Vacuum frame filling is a notable advance in filling technique which produces completely rigid packs of rectangular shape, easy to handle, stack and transport. The 'Diosack' is placed in a mould or frame on a special machine and compressed air is blown in so that the bag conforms to the shape and size of the mould. The bag is then filled, a vacuum of 8-10 in. is applied and the bag closed by a jaw-type sealer. Using two machines in tandem, a filling speed of one 50-lb. sack in less than one minute can be obtained.

The 'Lodematic' light-weight lifter seen in action

Eye Appeal

Marfae Polythene Co. Ltd. have produced a new polythene bag which is closed by folding the top, inserting a ring and fixing it by a 'thimble'. This 'Carri-seal' closure is simple and effective and this attractive pack, which appears to be very suitable for packing ready-cleaned vegetables, has a strong sales appeal.

Glass Containers

So great have been the technological and scientific changes in glass container production in recent years, and the quality of the products has been so improved, that today they bear little resemblance to the products of the past. Melting techniques and forming methods have been revolutionised and mechanised, so that attractive glass containers can be designed for packers of preserved fruits, jam and juices in a wide variety of shapes and sizes to suit individual requirements.

Sack Shaper

The *Reed Medway* 'Sac-Shaper' will produce symmetrically - packed sacks of both semi-flowing and free-flowing materials. It imparts to each sack a uniformity which saves storage space, makes for good and easy palletisation and improves stack stability. The 'Sac-Shaper' can be placed at the end of an existing conveyor or a Medway conveyor can feed the sewn sacks directly into the shaping unit.

New B.R. Service

British Railways, with *Collico Ltd.*, have begun a system for the transport of goods by freight or passenger service in special, easily assembled, collapsible cases of light steel or aluminium alloy.

New Publications

Coffee

Les Caféiers et les Cafés dans le Monde by Rene Coste, in two parts. In French. *Les Caféiers*, Vol. 1, 1955. Pp. 379. Price 80 N.F. unbound, 95 N.F. bound, plus 6.70 N.F. postage. Part II, *Les Cafés*, Vol. 1, 1959; Vol. 2, 1961. Pp. 884. Price 195 N.F. unbound, 230 N.F. bound, plus postage. Editions Larousse, 11 Rue Victor-Cousin, 11, Paris (Ve).

These three tomes, profusely illustrated with half-tone and line drawings, with innumerable tables of statistics, present a vast work on all aspects of coffee from the history of its use and planting, its botany, physiology, breeding and environmental needs, through nursery treatment, planting and cultivation throughout the world, to harvesting, curing, roasting, marketing and manufacture.

It is unfortunate that the first volume, which deals with the botany of this important crop, was published just before the taxonomy of the genus *Coffea* was disentangled from the confusion which existed in the world's herbaria and many of the so-called botanical species and varieties were renamed forms and cultivars of four economic species having less than half a dozen botanical varieties.

The naming of some of the shade trees, too, will need revision, especially the Albizias, and among the diseases and pests some names need bringing up to date, as for instance, the Coccids; *Pseudococcus* Sp., which in most cases have been renamed *Planococcus*. However, no author writing such a vast work over a period of more than six years could avoid such happenings. Even place names, such as the Belgian Congo, must now be altered to the Republic of the Congo.

If there is one criticism to make, too little is mentioned about the worst leaf disease, *Hemilea vastatrix*, and of the cultivars which have been found to show resistance. Little is said of Main's work in India and nothing apparently of the Rust Resistance Centre in Portugal.

The first volume of Part II deals with green coffee and its fermentation and preparation. It describes the machines used for curing, roasting and grinding; the classification of beans, chemical analyses, the actual brewing of drinking coffee and commerce.

The second volume deals with world statistics and then each producing country is described with maps showing the coffee areas. In each case the methods of cultivation are given with particulars of the climate and methods of production.

With bibliographies at the end of each chapter, these three volumes form a valuable encyclopaedia on coffee for those who require statistics or want to know anything about coffee.

A. E. HAARER

Polythene Film

Polythene Film in Horticulture. By H. R. Spice. Pp. 176. Illus. Faber and Faber, 1959. Price 18*s*.

Mr. Spice has studied the use of polythene film in horticulture both in Europe and in the U.S.A. His experience is now concentrated into a well-illustrated reference book which should be invaluable to those interested in modern technical developments in horticulture. This is a well-balanced and fair account written by an enthusiast of the sort who is necessary in the development of any new technique. Certain disadvantages of the material are dealt with; amongst these perhaps the most important is deterioration under ultra-violet radiation. Where necessary, he compares polythene with polyvinyl chloride, another film in fairly common use which has certain advantages and which may have an important future in horticulture.

The established use of plastic film in glasshouse lining is explained in detail. This is the first really economic system of providing a double skin for heat conservation on a commercial glasshouse. The author then goes on to discuss polythene as a substitute for glass and this chapter should provide a good starting point for anyone considering the use of plastics on forcing structures.

Polythene film has not, however, yet proved itself as a substitute for glass. Although cheap, it cannot be expected to last for more than one season. There is no doubt that in time cheap, long-lasting films will be evolved, expensive ones being already available. The lightness, pliability and large sheet size of this material demand revolutionary designs, but up to the present the structures used have been traditional lightweight greenhouses.

There is an interesting section on the use of plastic cloches, frames and tunnel covers. Tunnel covers have important commercial applications in several parts of the world. Simple half-hoops of wire or cane are placed over row crops or beds and these are covered by film dispensed from rolls mounted on a tractor. This is an important step forward in the recognition of film as a new material requiring new techniques. Such covers are particularly important in countries without an industry capable of producing cheap glass.

It is true that polythene offers little resistance to the outward passage of long-wave radiations at night, but this property is not shared by all plastic films and even glass structures, such as Dutch lights, provide only 5°F maximum temperature lift at night and this only after a sunny day. It is the high maxima and the positive temperature accumulations which provide the forcing effect on temperate crops in spring.

Polythene film is now used at all stages in plant production, particularly on intensive nurseries. At the beginning of the life of the plant it is used in propagation and at the end as a packaging material, for it is impermeable to water and partially permeable to oxygen and carbon dioxide. Other important uses of film discussed are plastic-lined reservoirs, the development of 'lay-flat' perforated tube for irrigation, the distribution of warm air in glasshouse heating and a variety of other uses too numerous to mention.

This book is of interest to growers in any part of the world; few could read it without picking up some useful ideas for the more efficient running of their holdings.

A. A. JACKSON

The Plant Community

By H. C. Hanson and E. D. Churchill. Reinhold Publishing Corporation, New York. 1961. Price 40*s*.

This small book provides 189 pages of very informative reading about the world in which we live. It might have been designed as 'A book to make

university students think'. Scientists will admire and appreciate the authors' presentation and mastery of a very complex subject and the book is one that should provide interesting reading for the general public. It merits inclusion in the recognised list of 'General reading' for all secondary schools.

There are those who contend that ecology is not an exact science, but few can deny that plant communities exist or that they are an ultimate expression of many complementary and conflicting patterns of adjustment to a specific environment. Any attempt to interpret and understand those patterns presents a challenge to our competence, because it demands unusual ability to integrate and apply knowledge of the basic principles in a great many exact sciences.

In the late thirties and early forties there was some antagonism to a rising interest in plant ecology, and this may have been a reaction to incipient dogmatism in its leading protagonists (Tansley in this country and Clements in America). However, there were still free-thinking individuals—undaunted by the general censure—who have continued their work; albeit with some change in emphasis, from the concept of a 'living organism' to a study of factors and conditions that control the distribution of individual species (for example, J. G. Wood in Australia). Now in this small book the authors have firmly re-established their concept and the authenticity of a plant community; as an entity and as the logical expression of its own environmental complex; moreover, they have done so without resort to any teleological* argument.

Minor criticism could come from practising ecologists, who may challenge a statement that in climax communities (aptly described as 'the endpoint in directional change') *there is usually an increase in complexity and diversity of species* (p. 156), and they may quote examples where a climax community is comprised of relatively few species. Those who live south of the Equator may well quibble about the advantages of 'a *southern aspect*'. However, there are few who will not admire a precise definition of 'competition' (p. 27); the authors' preference for 'ecological amplitude' over 'tolerance range' (p. 14); or their comprehensive and masterly chapter on 'The Dynamics of Communities'. Those whose interests lie in education may well admire the authors' capacity for inconspicuous and precise definition of ecological terms and their bibliography of carefully selected literature.

This small book is a vivid condensation of ecological principles. It could not have been written or compiled by men without a world-wide knowledge of plant communities.

T. B. PALTRIDGE

*Teleological: study of the evidence of purpose and design in nature.

Coir

Published by the Council of Scientific and Industrial Research, New Delhi, India. Pp. 54. Illus. 1960. Price Rs. 6.00 or 10*s*.

This book gives a brief account of processing, fibre structure and characteristics, grading, industrial uses, spinning, weaving, dyeing and trade statistics of the coir industry in India, with some references to production in other countries. India has a long record of research on this product. Investigations in the various states are now co-ordinated, a Central Research Institute has been established and co-operatives organised to provide financial assistance to small units in various sectors of the industry.

Coir is classed among the fibres which enter world markets in the form of fibre, spun yarn and floor coverings. India is the main centre of production, but even in that country less than 50% of the available coconut husks from which the fibre is obtained are utilised for this purpose. It follows, therefore, that an enormous quantity of husks is wasted in India and elsewhere and one wonders why, in view of the statement in this book that coir is in great demand, the industry does not assume greater importance. The answer appears in the penultimate chapter, where it is stated that 'depression in foreign markets in regard to coir goods on account of high cost or competition from other fibres is likely to result in adverse repercussions on Indian production'.

This monograph shows that coir production in India is still basically a cottage industry, and even in factories and co-operatives a large labour force is employed to operate the simple and in many cases primitive machines. On the evidence contained in this book it appears obvious that the success of the industry depends on better retting methods and a reduction in labour requirements by improvements in machinery and processing.

It is regrettable that this book does not give a more complete picture of coir production throughout the world; the bibliography will, however, assist the reader to a more comprehensive study of this product. F. C. COOKE

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Food and Agricultural Legislation. Vol. IX, No. 4, June 1961. Eight leaflets and an index. A quarterly series published in three separate editions, English, French and Spanish. Subscription per copy (four issues) $3.50 or 17*s*. 6*d*. Price per single copy $1 or 5*s*.

Food Additive Control in the Netherlands. Pp. 41. Price $0.50 or 2*s*. 6*d*.

Improvement in Olive Cultivation. Pp. 249. Illus. Price $2.50 or 12*s*. 6*d*.

Monthly Bulletin of Agricultural Economics and Statistics. Pp. 56. Annual subscription $5 or 25*s*. Single copies $0.50 or 2*s*. 6*d*.

All the above publications are obtainable from H.M. Stationery Office, P.O. Box No. 596, *London, S.E.*1.

Machinery and Equipment

Driers and Processing Machinery

Effective Seed Drying

Quick, adequate and uniform drying are necessary for good seed preservation even in temperate climates. In tropical climates insects, mites, fungi and their spores multiply much faster. Thus serious deterioration can occur when seed which is not adequately dried is in transit from one temperate country to another in its passage through a tropical climate, *e.g.* the Red Sea. This may well explain the failure of British grasses and legumes overseas.

Seed—a valuable commodity

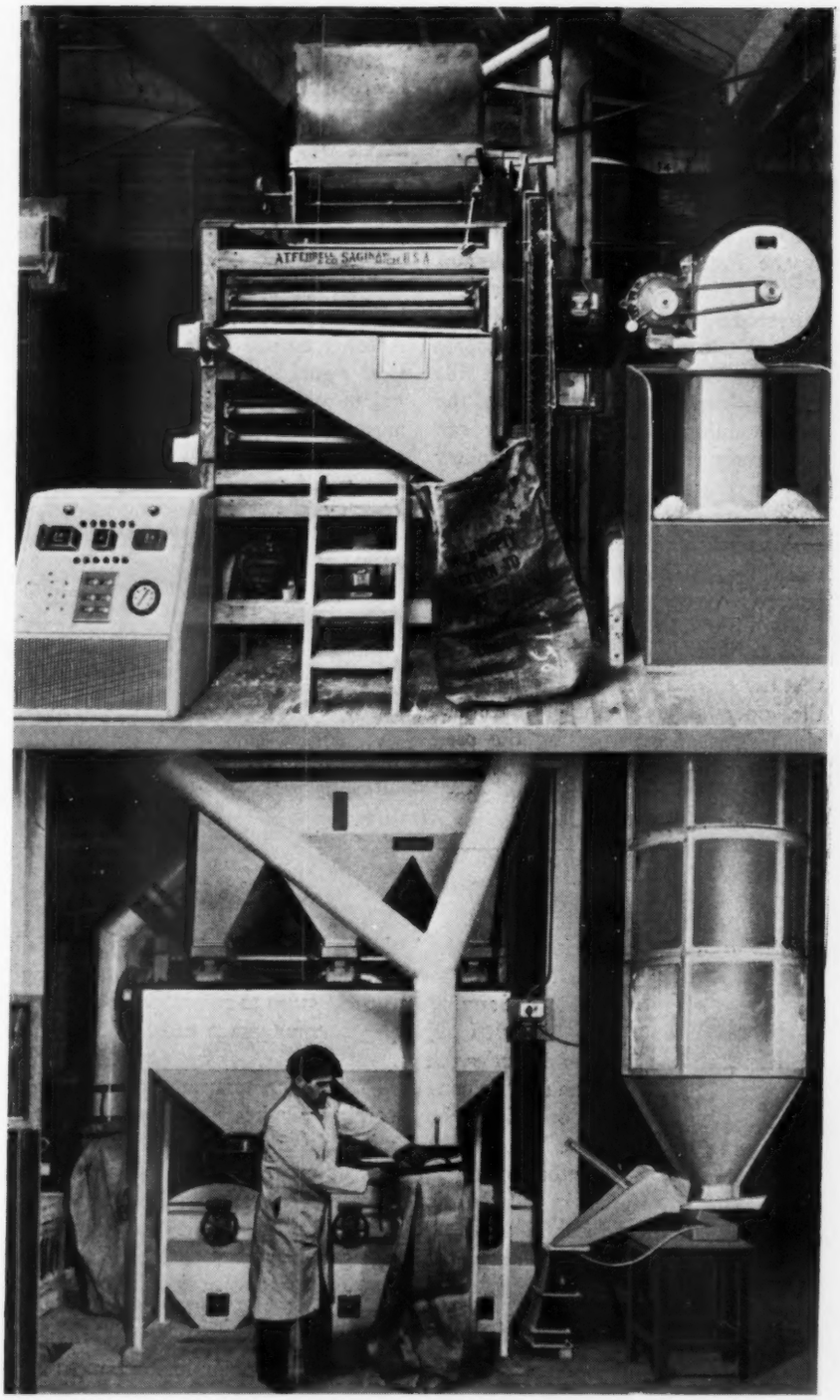
Good clean certified seed is a valuable commodity, yet there are farmers and seed merchants who do not appreciate the need for effective drying when the seed is required for early shipment abroad and even after collection by combine harvester.

Dry seed is healthy seed and seed for shipment should not contain much more than 5-7% of moisture. A moisture content of 14% may be regarded as safe for certain seeds in a temperate climate, but it is certainly not low enough for consignments of seed passing the Equator. If the moisture content is high, or if the moisture content varies from bag to bag, 'sweating' will occur, more moisture will be generated, and this will spread from bag to bag under the hot conditions which exist in the hold of a ship, *i.e.* up to 130°F.

The usual reason for the failure to ensure adequate drying is the fact that the farmers or seedsmen are not prepared to take the extra trouble and expense which separate drying entails.

New cleaner-drier

A drying unit is now available for converting an ordinary screen-type cleaning installation into a dual-purpose machine so that it will be possible to clean and dry seed and each separate grain of a batch of seed individually in one operation. The old-established firm, *R. W. Gunson (Seeds) Ltd.*, are responsible for the



A 'Dryex' unit as fitted to a two-storey grain-cleaning installation. On the top floor can be seen the fan and heater unit (right), *the control panel* (left) *and the heated cleaning screens* (centre). *The drying hopper on the bottom floor* (right) *is delivering the seed into an elevator for final drying in the warmed cleaner-shaker (top floor)*

introduction of this new system of cleaner-drying.

The new 'Dryex' unit consists of a drying hopper, a set of drying screens to replace the ordinary cleaning screens of the grain shaker and a control panel to regulate the drying. The unit requires no additional floor space and involves no extra labour or handling charges.

Three component parts

The hopper in which the preliminary drying is carried out consists of two perforated fibre-glass cylinders—one inside the other. The inner cylinder is 20 in. in dia. and the outer one is 36 in. in dia. The hollow centre of the inner cylinder is a plenum chamber into which warm air is delivered by an electric fan-and-heater unit. The seed is fed in continuously from the top of this hopper and fills the 8-in. gap between the walls of the two retaining cylinders and air can pass freely through the 8-in. hollow column of grain.

After this preliminary drying the grains receive individual contact treatment by passing over two sets of warmed cleaning screens, which are heated by a low-voltage current of electricity. The voltage used is so low that there is not the slightest danger of the operator receiving an electric shock, nor of over-heating the seed under treatment. The temperature of the screens can be raised to about 170°F or 77°C, according to the nature of the seed.

The third component of this unit is the control panel, which contains the necessary electrical connections and a low-voltage transformer which is connected to the mains supply. When it is not required to dry the seed, the current can be switched off, so that the grain shaker will function merely as a cleaner.

Performance trials

The rates of moisture extraction will, of course, depend on the size and nature of the grains. The performance figures shown in Table 1 are a summary of results obtained by the company during three years of actual commercial use of standard 'Dryex' units in their seed warehouses in London. Another typical performance of practical significance is the extraction of 5% of moisture from seed wheat with an initial moisture content of 19% on a throughput of 20 cwt. per hour.

Improved germination

It is claimed that this system not only improves the keeping qualities of seeds by drying them down to a safe moisture content, but it can also speed up germination. The company instances the case of a grass seed, cocksfoot. Normally this shows 45% germination in seven days, 85% in 14 days and 90% in 21 days. After treatment by a 'Dryex' unit they obtained 85% germination in only seven days.

Furthermore, the contact heat which each individual grain receives on the screens opens up new possibilities for driving away or destroying insects and mites, and their eggs, and also the mycelia of fungi and their spores on the surface of the seed.

Thus it is now easy to safeguard a seed crop against many hazards by drying it thoroughly in a seed cleaner so equipped that cleaning and drying can take place at the same time and without any additional labour and handling costs. In this new unit drying is continuous and each grain receives individual treatment, so there will be no moist pockets of seed to act as decay centres during the subsequent shipment of a consignment.

Table 1

Moisture extraction rates

Throughput cwt./hr.	*Moisture extracted* (%)			
	Ryegrass	*Cocksfoot*	*Timothy grass*	*Kentucky blue*
4.0 ..	10.0	8.0	12.0	10.0
8.5 ..	5.2	4.2	6.6	5.2

Grain Drying

A system for the efficient and controlled drying of grain and designed to operate on a 230-v. a.c. electric supply has been designed by *Negretti & Zambra*. This installation includes the following components: an electric contact hair hygrometer, located at the inlet duct to measure the humidity of the incoming air; a motorised fan to suck in air; two banks of electric heaters to warm the air; a dial-type indicating thermostat to sense the temperature of the heated air; and a second hair hygrometer located at the top of the grain chamber to measure the relative humidity of the outgoing air. All these components are interconnected and monitored through a relay unit.

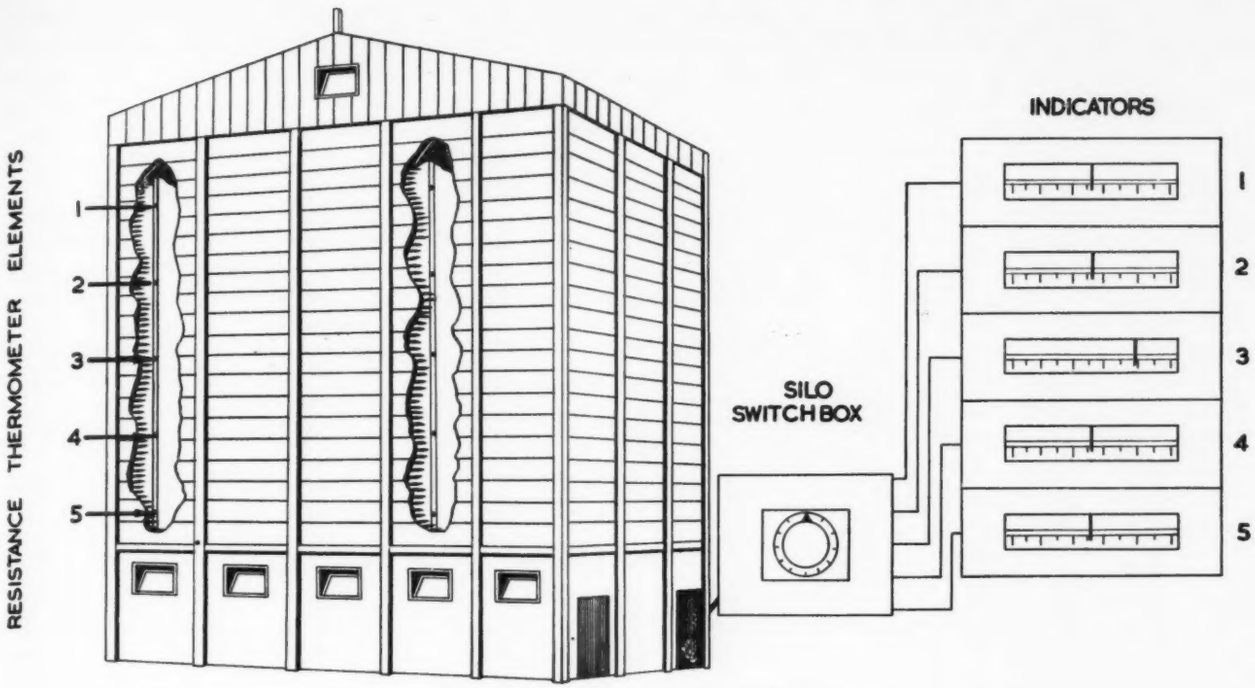
With this system the temperature of the drying air is sensed by the bulb of the thermostat, which acts through the relay unit to switch on or switch off the heaters (coarse and fine) in the air duct.

When the temperature of the incoming air has risen to a predetermined level the thermostat will switch off the coarse heater, leaving the fine heater in operation. The temperature of the drying air will continue to rise, but at a slower rate, until it reaches a predetermined maximum, when the fine heater also will be cut out automatically.

Conversely, should the temperature of the drying air fall below a certain value after both heaters have been switched off, the fine heater will first operate, and if this alone is insufficient to maintain the temperature within the required range the coarse heater will be reintroduced.

The drying process is automatically terminated when the relative humidity of the outgoing air has been reduced to the required level, thereby avoiding damage to the grain in the drying chamber through over-drying, and thus also minimising the use and cost of electricity.

This sequence of operating controls precludes any possibility of the incoming air reaching an excessively high temperature and producing a skin-drying or case-hardening effect on the grain, whereby the inside of the grains are still moist but the moisture cannot escape. There is also no risk of moist air being introduced into the



Grain silo temperature measurement system

dried grain, as the outlet hygrometer automatically acts through the relay unit to switch off the suction fan in the inlet duct.

Grain temperatures

The same company also produces recording thermometers for the measurement and indication of the temperature of stored grain in bins and silos at several predetermined depths.

The installations may range from that required by a single bin to a complete unit for 100 silos recording at a central point and at the same time indicating the temperature of the grain in each silo in turn at nine predetermined depths, with 900 points of measurement in all.

The temperatures in a selected silo are indicated simultaneously, so giving a clear picture of the conditions within and providing early warning of any incipient over-heating.

Portable Drying Unit

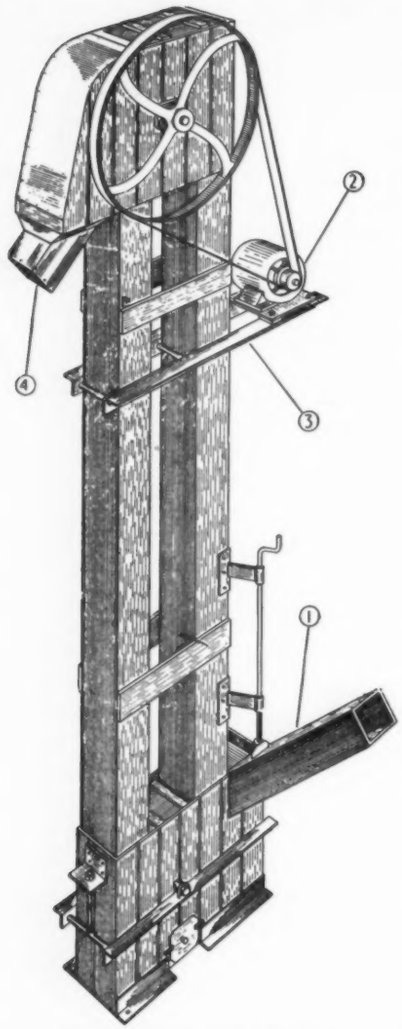
Unless weather conditions after cutting are favourable, hay left in the field to dry will lose most of its nutriment and palatability. If facilities are available for artificial drying the grass can be cut when it is young and most nutritious, and wet grass can be brought in and dried either as a stack of bales or on a weld-mesh platform using a *Trojan* 'Airator'.

With this unit wet grass may be dried in-barn and in-bale from, say, 50-15% moisture content in 10-ton lots in about 80 hours, and the resulting hay will be of high quality. This unit will also provide ventilating air at variable temperature and volume for all forms of crop conditioning and drying (see also WORLD CROPS, 1959, 11, 154 and 372).

Grain Elevator Equipment

The *Whitlock* grain elevator, model 9901, is fitted with an inlet chute (1) with screw feed adjustment, an electric

The Trojan 'Airator' is a mobile, independent unit incorporating a heat exchanger; it is powered by an air-cooled, twin-cylinder diesel engine of 10 h.p.



The Whitlock grain elevator

motor (2) to suit the type of power supply, a speed reduction unit (3) to drive the elevator at the required speed and a special outlet piece (4) which can be supplied to deliver in a number of directions or give a vertical fall.

The capacity is from 2-4 tons per hour for their double elevator, type 9960. The height of the elevator can be altered if at any time it is required to alter the layout of an installation. An inspection window makes it possible to adjust the feed and speed to obtain maximum efficiency and a minimum spill back.

Batch Drier

The latest *ScotMec* grain drier is totally enclosed and so bird- and vermin-proof. It is of unit construction and can be assembled with unskilled labour. It is claimed to give rapid mixture extraction at a safe low temperature.

The features of this drier are: (1) an automatic oil burner; (2) photo-electric controls (in case of flame failure); (3) combustion chamber; (4) thermostat to prevent over-heating; (5) multi-vane blower for conveying and drying; (6) box connector with cold air mixing slide; (7) hot air inlet to plenum chamber; (8) two-way valve; (9) blast control; (10) temperature gauge; (11) duct thermostat; (12) grain-sampling tube; (13) venturi grain injector; (14) discharge hopper; (15) discharge lever handle; (16) two-way valve to direct the grain either into the drier or to the silo when it is dry; (17) overflow sleeve.

Farm Heater

Senior Combustion Ltd. have announced the introduction of the 'Safax' farm heater, designed by a farmer for the farming community. It is an all-purpose unit, which can be used for drying grass and grain, for the destruction of small carcases and for boiling water and pig swill.

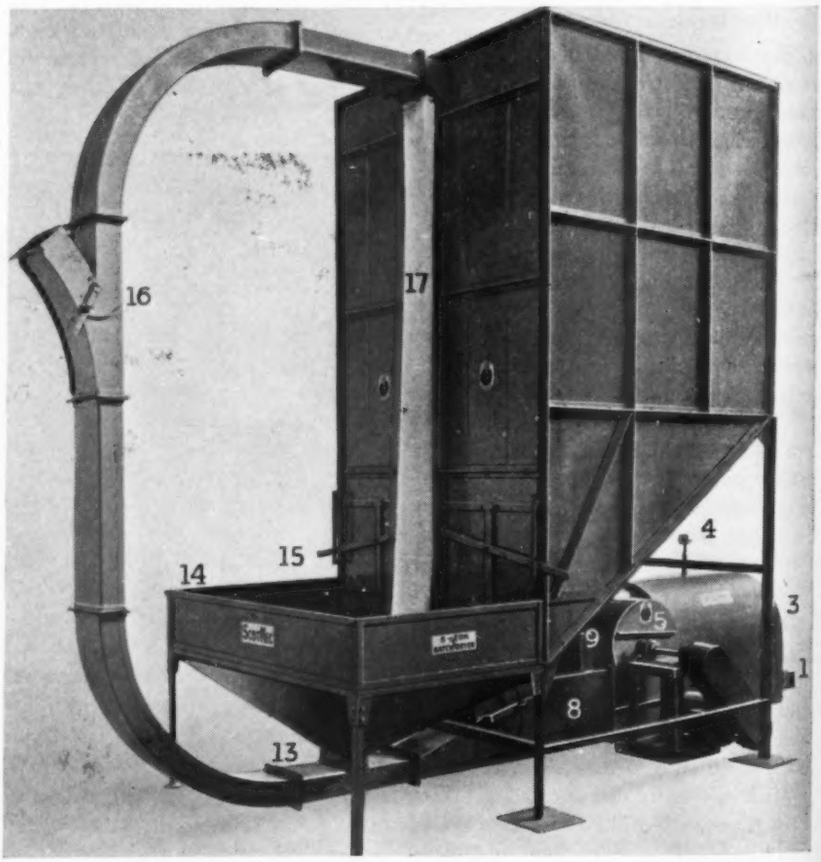
The heater stands on a base plate, 4 ft. x 3 ft., and can be wheeled to where it is to be used and plugged into a 15-amp. power point. The unit has two electrically-driven twin fans, which permit an adjustment of the air flow, and it can be fitted with automatic switch-off and time control.

The fuel used may be either diesel oil or kerosene and the 6-gal. fuel tank is fitted with an oil filter, depth gauge and control valve. The fuel consumption is about ½ gal. per hour and it is claimed that in this time it will remove 5% of the moisture in 1 ton of grain.

Advice on Drying

Woods of Colchester have appointed Mr. E. B. Robinson, A.INST.M. & M., to represent their interests in West Africa from Dakar to the Congo and to give advice on drying processes and heating and ventilating problems and, in particular, cocoa-, coffee- and tea-drying installations, tunnel driers for rubber and grain driers.

Mr. Robinson, who will make his headquarters at Lagos in Nigeria, has an intimate knowledge of the territory, having spent 12 years in West Africa.



The ScotMec 5-ton batch grain drier is a compact unit

Agricultural Chemicals

Seed Dressing and Wild Life

In reply to questions asked in the British House of Commons by Mrs. Joyce Butler, M.P., and Mr. F. V. Corfield, M.P., about the future use of toxic cereal seed dressings in the light of reported cases of deaths of birds, the Minister of Agriculture, Fisheries and Food, the Rt. Hon. Christopher Soames, C.B.E., M.P., said:

'The report of the survey we have been carrying out shows that the widespread occurrence of deaths of birds has been confined to springtime, and that the main trouble could be obviated by not using dressings containing dieldrin, aldrin and heptachlor on seed for the spring sowings.

'Accordingly, it has been agreed that as from 1 January, 1962, these dressings will not be used at all for the spring-sown grain, and they will only be used for dressing autumn and winter wheat where there is a real danger of attack from wheat bulb fly'.

Seed Dressing Range

Following these recommendations of the Ministry of Agriculture, *British Schering Ltd.* announce that they will cease to use aldrin in their liquid formulation for wireworm control and in their granadin dual-purpose powder dressing as from 1 January, 1962.

The seed dressings which will thereafter be available to seed merchants will be as follows:

For disease control

'Abavit B' powder seed dressing.

'Mist-O-Matic' mercury liquid seed dressing.

For wireworm control

'Granadin' powder seed dressing, based on BHC.

'Mist-O-Matic' wireworm liquid seed dressing, based on BHC.

For wheat bulb fly control

'Granadin W' powder seed dressing.

'Mist-O-Matic' wheat bulb fly liquid seed dressing.

More Basic Slag Used

Consumption of basic slag by farmers in Britain is increasing rapidly. During the year ending June 1961 usage of home-produced basic slag reached 740,000 tons, an increase of over 1,000 tons compared with the average for the three years 1957-59. It is remarkable that this has taken place in a year when field conditions during the winter months were probably the worst in living memory.

The former practice of applying it only in winter to established grassland was based on the belief that slag was slow acting. Experience has shown that slag of high-citric solubility can be very effective when applied during the summer months, when the going on the land is easier and supplies are more readily available. In areas where drought has affected undersown seeds a dressing of 10 cwt. of basic slag in the stubble when it can reach the soil quickly, can be an excellent investment.

Foliar Feeding

Most gardeners think of plant feeding as a matter of applying nutrients to the soil to be taken up through the roots, but leaves also can take in plant food. One important characteristic of foliar applications is their greater efficiency as compared with soil applications. Thus about 10 times as much phosphorus needs to be applied to the soil as is needed for an equal response from a foliar application. This is because so much of the soil-applied phosphorus fertiliser is 'fixed' or otherwise dissipated in the soil.

In the last 10 years an organic foliar spray called 'Sea Magic', based on liquefied seaweed biologically balanced with selected land plants, has been developed by *Chase Protected Cultivation Ltd.* This hits the target in three ways. First, it supplies every mineral nutrient, including the trace elements needed for the complete nutrition of the plant; secondly, it contains auxins and hormones, which produce healthy and vigorous root growth, ensure earlier and heavier crops and give greater resistance to pests and diseases and to excessive cold and drought; and, lastly, it stimulates the bacteria by providing the necessary mineral nutrients for them, to carry out nitrogen fixation and other biological processes.

Nitrogen and Cotton

According to an information paper recently issued by *Chilean Nitrate Agricultural Service*, the results of investigations carried out at four agricultural experiment stations in the U.S.A. have led to the following general conclusions with regard to the nitrogenous fertilisation of cotton:

(1) Sodium and potassium have a negative interaction, *i.e.* the presence of either element diminishes the effect of the other. The two elements have similar characteristics and can substitute for one another. This substitution can be very substantial, but can in no case be total.

(2) In the presence of the optimum dressing of potassium sodium generally increases the yield of cotton. This indicates that sodium also has a specific function in the cotton plant.

(3) If sodium is included in a mixed fertiliser formula as the ion associated with nitrate, the potassium dressing can be reduced considerably without affecting the yield.

(4) Nitrate of sodium reduces the loss of potassium in the soil drainage water. This action may explain the superiority of nitrate of soda over nitrogenous fertilisers which do not contain sodium. It also helps to explain why the use of nitrate of soda makes it possible to use lower rates of potash without loss of production.

Control of Grasses

'Eptam' is a selective pre-emergence herbicide which controls grassy weeds as they germinate and prevents the growth of nutgrass tubers, according to the *Stauffer Chemical Co.*, who recommend it for the control of such weeds in potatoes, beans, alfalfa, flax and safflower.

The active ingredient is ethyl di-n-propylthiolcarbamate, and the liquid formulation contains 6 lb. of this ingredient in every gallon. It will not corrode equipment, is non-abrasive and is described as easy to handle. This, however, does not mean that normal precautions need not be taken —for it is dangerous to swallow, it must not be allowed to come into contact with the skin and the operator

must wash himself thoroughly after he has used it.

The product is offered in two formulations: 'Eptam 6-E'—an emulsifiable concentrate which is easy to dilute with water for spraying—and 'Eptam 5-G'—free-flowing granules for easy spreading.

The herbicide is applied directly to the surface of the soil, either by spraying or in the granular form, and within minutes of its application it must be incorporated into the soil with a rotary hoe or spiked tooth harrow. The application is usually made just before the seeds of the crop are planted.

For Pesticide Formulations

A technical brochure which describes and evaluates seven types of polyethylene glycol may be obtained from *Allied Chemical International.* These organic compounds have similar reactions to the hydroxyl groups in the alcohols and lower glycols, but their exceptional emulsifying ability, solvent action, water solubility and resistance to deterioration are most important in the formulation of agricultural chemicals.

Polyethylene glycols with the basic formula $HO(CH_2CH_2O)_xH$, blend readily with other materials. They are odourless and practically colourless, have a low vapour pressure, high flash point, high chemical stability, high thermal stability and low toxicity.

Those with m.w.s up to 600 are viscous liquids at room temperatures. The melting or freezing points, the flash point, viscosity and specific gravity increase as the m.w. increases. Conversely, the vapour pressure, hygroscopicity and solubility in organic solvents decrease as the m.w. increases. Although highly soluble in water and in other substances, they are only slightly soluble in aliphatic hydrocarbons.

Codling and Tortrix

These moths are now regarded as the two worst pests in the apple orchards of Britain. Both can seriously reduce the quality and value of the crop, with a consequent financial loss, which it is well worth while to prevent.

DDT, in most cases, is an effective insecticide to use against the codling moth, but there are instances when the control it affords is no longer satisfactory; there is also need for a product with greater persistence, since egg-laying by the moth can sometimes extend over a long period, with a consequent lengthening of the period over which the caterpillars attack.

A new insecticide, based on 'Sevin' and marketed as 'Murvin Fifty', is stated to be effective against codling moth in these circumstances; it is also able to kill the caterpillars after they have penetrated the skin of the fruit. According to the severity of the attack, repeat sprays of either DDT or 'Murvin Fifty' may be required at intervals of three weeks.

For tortrix control only DDT is still considered to be highly efficient against the first attacks, but the *Murphy Chemical Co. Ltd.* have recently carried out trials with a new material called 'Rhothane Wettable' and have found it to be the most efficient of all the products they have tested. Where the attacks of tortrix are heavy, applications should be at intervals of two weeks.

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Manuring Tobacco

Green Bulletin No. 7, issued by the *Verkaufsgemeinschaft Deutscher Kaliwerke G.m.b.H.*, gives information, obtained from many sources, on the subject of the science and practice of the use of potash in tobacco culture. From the communications emanating from tobacco-growing countries with different climatic conditions it appears, in general, that for growing tobacco a light, deep soil with a good humus content and a neutral to slightly acid reaction is most suitable.

The nutrient removal by the plant varies within wide limits according to the variety and in this connection the calcium/potash ratio is important.

Potash deficiency is dealt with in detail. Its recognition is particularly important because, with the occurrence of potash deficiency, the leaves of the plant become more or less unusable, and therefore worthless.

After a general introduction dealing with the effects of the different nutrients and a consideration of the chloride problem in tobacco growing, the results are reproduced of various experiments in a number of important tobacco-growing countries. The subjects investigated comprised the effect of potash on yield and on the various factors determining quality in tobacco.

Finally, the manurial treatment in the seedbed and in the field in tobacco culture is discussed. In addition to the use of organic manures, special attention is paid to the use of fertilisers and the composition of fertiliser mixtures in the various growing districts. Generally there appears to be a growing tendency to use compound fertilisers with still higher potash contents.

Directory of Pesticides

This Directory is published by the *Association of British Manufacturers of Agricultural Chemicals* to give intending purchasers of crop pesticides information on the products made by their members. Products are listed alphabetically, either under a generally accepted common name or the chemical name, wherever possible, either as the basic material or as its formulations in the form of dusts, sprays, aerosols, and special preparations for aerial application, together with the names of all the manufacturers of each of these preparations.

Another important section lists the patent, proprietary and trade names of insecticides, fungicides, weedkillers and related products, followed by a brief description and the name of the manufacturer of each product. This will meet a long-felt need of users who are overwhelmed and confused by the multiplicity of trade names and the complexity of the chemical names and formulae.

The Directory is issued gratis to large-scale users or purchasers of pesticides and copies may be obtained through our Reader Service.

World Crop Reports

INTERNATIONAL REPORTS

Sugar

After a millennium of development in the East, sugar-cane came to Europe, spread rapidly around the Mediterranean and finally crossed the Atlantic with Christopher Columbus (1451-1506). In the last quarter of the 19th century modern industrial methods have been applied both to sugar-beet and to cane sugar, and the past 80 years have been a period of spectacular expansion.*

Statistics show that in the past 80 years world production of all types of sugar has increased tenfold. During the 61-year period 1899-1960 world consumption of factory sugar increased by five times at an annual rate of 3%, but real prices—that is, prices compared with the cost of living—have gone down.

This overall growth conceals the competition between sugar-beet and cane sugar. In the last two decades of the 19th century various factors helped to increase beet sugar production from 1.5 to 5.2 million tons, and cane sugar production during these two decades rose by only 60% from 1.8 to 2.9 million tons. By the end of the 19th century beet sugar was contributing 65% of total world production of 8 million tons.

The turn of the century, however, saw the picture change and the trend was further accelerated by the First World War. In 1924-28 cane sugar production was 380% higher than at the end of the century and was contributing 60% to world sugar supplies. Since the end of the Second World War both beet and cane sugar have advanced rapidly, but in the last few years cane sugar appears to have advanced slightly more.

With this increasing total production yields per acre have more or less doubled in the past half-century for both crops and still there is considerable scope for an increase in sugar production. The world average consumption per head in 1959 was only 35 lb. In Europe it was 77 lb., while in 20 high-consumption countries it was around 110 lb. If world consumption were to reach the average level of that of Europe, existing world production, 58 million tons, would need to be doubled.

Sugar-cane of the 'Pindar' variety, 16 months old, growing in North Queensland. This was a successful new cane variety bred by C.S.I.R.O. which was distributed free to cane farmers

Pattern of exports

During the 61-year period 1899-1960 total world consumption increased fivefold and *per caput* consumption was doubled. Since the Second World War the increase in consumption has been more rapid than in any previous period and greater than that of any other major food, but this growth rate has not been uniform in all parts of the world.

Between 1890 and the outbreak of the First World War in 1914 world exports of sugar almost doubled, from 3.9 million tons to 7.5 million tons. At the outbreak of the Second World War in 1939 about 10.5 million tons of sugar moved in international trade. In 1958-59, 15 million tons of sugar were traded.

The two wars drastically changed the pattern of exports and imports. Russia and Germany practically disappeared from the export market after 1920 and Indonesia after 1945. Their places were taken by Cuba, British Commonwealth countries, Dominican Republic and others.

Changing pattern in U.K.

One of the most interesting examples of change in the pattern of trade is that of the U.K. There was no domestic production of sugar at all in Britain before the First World War and 75% of its imports of 2 million tons came from European beet-producing countries. Only 25% came from the cane-growing areas, including 6.5% from Commonwealth sources.

During the last years before the Second World War U.K. imports from Europe declined to a mere 2½% of the total imports of 2.3 million tons, and Commonwealth countries stepped up their exports to the U.K. from 133,000 tons to 1.2 million tons. At the same time, home production increased from zero in 1920 to 490,000 tons.

The Second World War gave further impetus to this trend. In 1959, 96.5% of total U.K. imports of 2.6 million tons came from cane-producing countries, the Commonwealth contributing 65% of this, while domestic production of sugar went up to 800,000 tons.

Simultaneously with increased production and trade, world stocks of sugar have also increased. During 1924-26 stocks were the equivalent of 16 weeks' consumption. By 1931-32 they had risen to the equivalent of about 28 weeks' consumption, an accumulation directly related to the sharp fall in world prices. Following this there has been a gradual reduction in stocks. In 1934-38 world stocks amounted to about 20 weeks' consumption and by 1954-55 stocks were only

* *World Sugar Economy in Figures*, 1880-1959. Published by FAO in co-operation with the International Sugar Council.

enough for 16 weeks' consumption. Although in absolute terms the size of stocks a few years ago was 30% higher than in pre-war years, in terms of world weekly consumption stocks were 40% lower, a reflection of the expanding market for sugar.

Maize

The world maize crop in 1960 reached a record figure of 8,200 million bushels, some 260 million bushels above the previous record set in 1959.

Most of the increase in world production was in the U.S.A. and the U.S.S.R. Other increases are reported for Western Europe, Africa and South America. Output was slightly lower in Asia and Eastern Europe.

In U.S.A. production reached 4,648 million bushels, *i.e.* more than one-half of the total world harvest. In the U.S.S.R. farmers harvested more than 600 million bushels, as compared with the 1950-54 average of 190 million bushels.

In Western Europe the crop ran 332 million bushels, a new record, greater production in France being a major contribution. In Eastern Europe the harvest is estimated at 658 million bushels, well above the 1950-54 average, but lower than the previous year.

Asian farmers harvested 845 million bushels of maize, which is slightly less than in the previous year, but much higher than the 1950-54 average. In Africa the output was 165 million bushels, larger than expected, mainly due to production increases in South Africa.

Citrus

The 1960-61 world orange and lemon crops were smaller than in the previous year, but grapefruit was slightly higher.

Oranges: World orange production is estimated at 373 million boxes, or 6 million boxes smaller than the previous season. This smaller crop—a temporary interruption in rising production—is the result of a hurricane in Florida, drought in South Africa, and poor fruit sets in Mexico, Spain, Algeri-, Israel and Italy.

Grapefruit: World grapefruit production will be about 49.5 million boxes, about 1.5 million boxes larger than last season because of increased production in the U.S.A., which grows about 87% of world supplies. Grapefruit production in Israel and the U.S.A. is expected to increase in the future.

Limes: World lime production declined about 300,000 boxes to 3.7 million boxes because of lower production in Mexico and abandonment of some Mexican groves. Little change in future world supplies is expected.

Lemons: World lemon production is estimated at 35.6 million boxes, 5.8 million boxes less than the previous season. This is the smallest crop in three years because of reduced production in all major producing areas—Spain, Italy and the U.S.A. Lower production in Italy is the result of a small winter lemon crop which was not offset by a record, early Verdlli summer lemon crop. Future lemon supplies are expected to increase as new plantings come into bearing.

REGIONAL REPORTS

Venezuela

The 1961 *sesame* crop was a record at 26,700 tons, being favoured by unusually prolonged rainfall. Government credit enabled farmers to make good seed selections.

Mexico

The *rice* acreage in 1961 is expected to increase by about 7%.

The area is forecast at 358,000 acres —about 25,000 more than the previous record area under rice in 1960. Both Sinaloa and Vera Cruz—the two leading rice - producing states — are planting more land with rice.

If prospects for the large crop materialise supplies should meet Mexico's rice requirements in 1961.

India

The first official estimate of the current Indian *flaxseed* crop, harvested during February-April 1961, is 372,000 long tons. This is 12.5% lower than the final estimate of 425,000 tons for the 1960 crop.

Most of India's flax crop is crushed for oil and during the past five years only one-fifth of the oil produced has been exported.

New Zealand

This year's *apple and pear* crops have been a record. A spokesman for the Apple and Pear Board said that 4.1 million cases of apples and pears had been produced this year. Better production methods and increased plantings have produced the increase. Nelson was the main supplier and just over 2 million boxes had come from that area.

Rhodesia and Nyasaland

The Southern Rhodesia flue-cured *tobacco* crop in 1959-60 was a record—207 million lb. with an average yield of 1,050 lb. per acre. This compares with 180 million lb. at an average yield of 880 lb. per acre in the previous year. The preliminary forecast of the 1960-61 crop is 215 million lb.

The crop grown in the north-western sector of Northern Rhodesia—that is, the leaf sold in the Salisbury auctions alongside the Southern Rhodesia leaf—was 10.8 million lb. in 1959-60, much the same as in 1958-59. The yields per acre were 847 lb. and 947 lb. per acre respectively. The preliminary forecast for the 1960-61 season was 15 million lb., making, with the Southern Rhodesia crop, a total of 230 million lb.

The North-Eastern Rhodesia crop was 1.6 million lb. in 1959-60, with a yield of 802 lb. per acre, compared with 1.68 million lb. at a yield of 727 lb. per acre in 1958-59. The preliminary forecast for the 1960-61 crop is 1.6 million lb.

The flue-cured tobacco crop in Nyasaland in 1959-60 was 2.9 million lb., compared with 2.2 million lb. in the previous year. This, however, is a small part of the total production, which is mainly fire-cured and sun-cured.

Papua and New Guinea

Coffee production in Papua and New Guinea is increasing steadily. Production rose from less than 1,000 tons of raw coffee beans in 1959 to about 2,000 tons in 1960. The estimated crop for 1961 is 3,000 tons.

A survey of the industry carried out by the Australian Bureau of Agricultural Economics has revealed that high capital investment is needed for the efficient production of coffee. The Bureau estimates that to establish an efficient plantation of 100 acres of *arabica* coffee in the New Guinea highlands a capital of about £55,000 would be needed over a period of six years.

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